# MODERN PLASTICS

OCTOBER 1945

With this issue MODERN PLASTICS begins its third decade of service to the plastics industry

# Versatile Plastic Effects Manufacturing Economy

*Probably no other field uses more plastics than electrical manufacturing. The myriad of electrical products on the market today call for thousands of versatile-propertied plastic parts. The majority of these parts are molded from phenolic compounds because the phenolics are the most versatile of all plastics*

Since its inception the plastics industry has been prone to stress volume when it comes to molded plastics applications. At times, applications where plastics fit the job better than any other material have been passed up because the number of parts required was so limited. However, there are many instances where the inherent physical properties of plastics so far outweigh higher costs due to small volume that the end result warrants the use of these materials. Such was the case with Budd Induction Heating, Inc., who use the heavy molded Durez parts illustrated in their induction heating machines, and who found that the molding of plastics was more practical and economical than machining.

### Electrical Resistance Required

Induction heating machines employ high-power, high-frequency currents and naturally require a plastic material with excellent electrical properties for many of their vital parts. In addition, they require a material of high impact strength In short—and like so many instances in electrical manufacturing —they require a material that is versatile. Therefore, the choice of a Durez phenolic compound for this purpose was a most logical one.

### Molding Ingenuity

As molders of the large, heavy plastic terminal assembly illustrated, Michigan Molded Plastics, Inc., in collaboration with engineers of Budd Induction Heating, Inc., accomplished a feat which typifies the ingenuity of America's custom molders. They took a versatile, high-impact Durez phenolic molding compound with unusually excellent electrical properties and molded a 3-piece terminal assembly for an induction heating machine which not only replaced an original assembly consisting of five pieces but did it with tremendous savings in time and costly machining.

### Versatile Phenolics

Too much can't be said about the versatility of phenolic plastics. Such properties as dielectric strength, diversity of finishes, excellent moldability, impact strength and highest dimensional stability at temperature extremes, as well as resistance to moisture, heat, mild acids and alkalies, are inherent characteristics in all of the more than 300 Durez phenolic molding compounds.

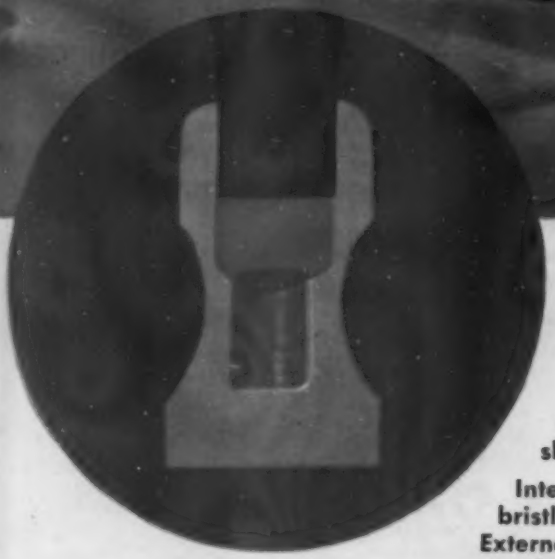
Perhaps you are looking for the plastic that fits your job. If so, you should make Durez your starting point. The services of experienced Durez technicians are available at all times for your benefit. Durez Plastics & Chemicals, Inc., 2610 Walck Road, North Tonawanda, New York.

DUREZ

PHENOLIC RESINS

- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- OIL SOLUBLE RESINS

**PLASTICS THAT FIT THE JOB**



# Catalin THE GEM OF PLASTICS . . . IN A DUAL ROLE!

**Here, two Catalin plastics serve as prerequisites to perfect shaving!**

**Internally, a liquid Catalin resin (Catabond 450) bonds the bristles — permanently anchors them firmly within the core. Externally, Catalin, the gem of plastics, bases the bristles in a mounting of proper poise, weight and balance.**

**Economically cast, these brush grips accentuate Catalin's incomparable richness of color, handsome splendor, water resistance, strength and stability . . . are indicative of the sales appeal and utility value which Catalin can bring to brush designs of various types and for all purposes.**

**If you have a product problem, call upon the wide experience of Catalin's technical staff to work with you. Inquiries invited.**

**For years, the famous "Ever-Ready" Shaving Brushes have been handsomely handled in Catalin . . . the models here are illustrative of Catalin's richly colorful sales appeal.**

**CATALIN CORPORATION · ONE PARK AVE., N. Y. 16**

**CAST RESINS • LIQUID RESINS • MOLDING COMPOUNDS**

# Modern Plastics

AND PLASTICS

★ ★ ★

OCTOBER 1945

VOLUME 23 NUMBER 2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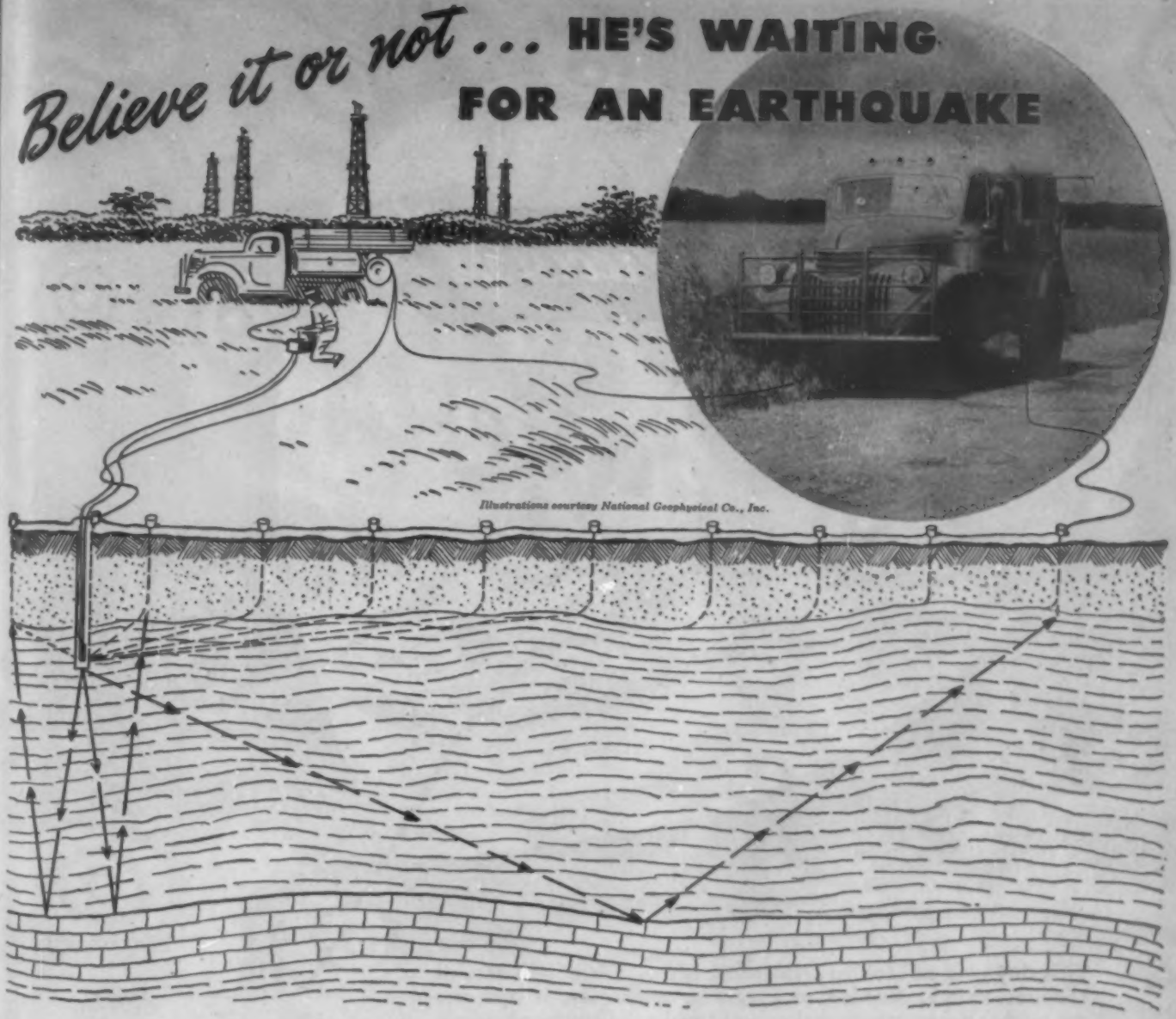
*Member Audit Bureau of Circulations*

# *Believe it or not* ... HE'S WAITING FOR AN EARTHQUAKE



*Illustrations courtesy National Geophysical Co., Inc.*

ONE of the best ways to locate a new oil pool is with artificial earthquakes, set up by dynamite charges and recorded on a portable seismograph carried in a truck like the one in the picture. The vibrations, after bouncing off an underground rock formation, return to the surface where they are changed into electrical impulses that are carried *through wire* to the recorder.

Any break in the wire insulation or any electrical loss caused by poor insulation would result in undependable readings—wasted time, wasted money. That's why wire insulated with GEON is used in this service. In addition to excellent electrical properties, this raw material imparts to insulation—and thousands of other finished products—more than 30 separate important and unusual properties—*that can be selected to provide exactly the right combination of properties for your finished product.*

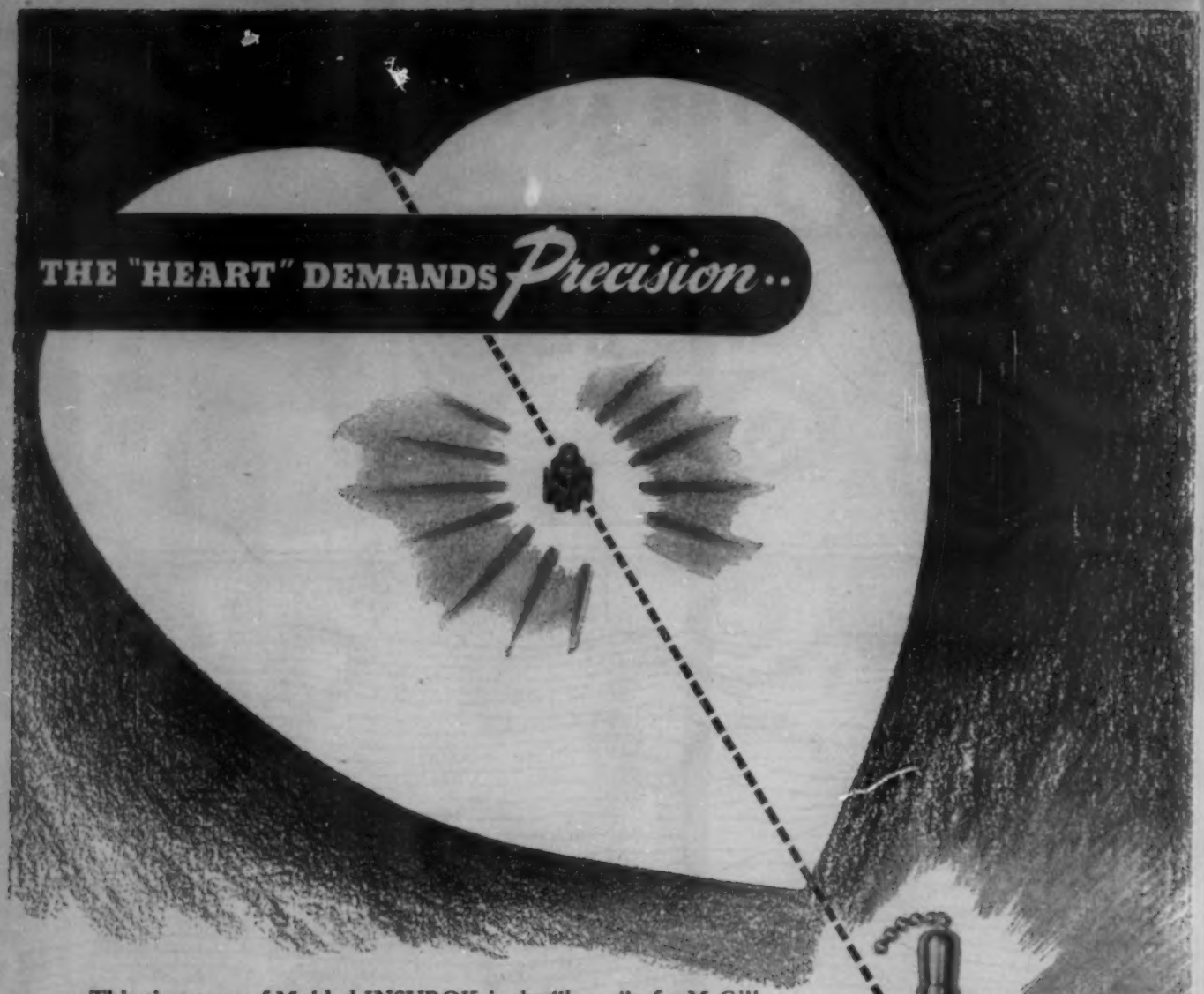
For example, GEON can provide resistance to water, sunlight, air, aging, abrasion and wear, oils, chemicals, acids, foods, heat, cold, mildew, flame, and many other normally destructive factors. Products made from GEON may be rigid or flexible—brilliantly or delicately colored.

GEON raw materials may be made into a transparent packaging material that can be heat-sealed—or scuff-proof luggage and brief cases that will wear indefinitely—or shoe soles and heels that will last as long as the uppers—or upholstery material that can be left outdoors because it resists the action of sun and rain. There will be uses for products made from GEON in *every* industry. For more information please write B. F. Goodrich Chemical Company, Department II-10, Rose Building, Cleveland 15, Ohio.

Geon
Polyvinyl Materials

**B. F. Goodrich Chemical Company**

A DIVISION OF THE B. F. GOODRICH COMPANY




This tiny gear of Molded INSUROK is the "heart" of a McGill Levolier switch. Molded to precision tolerances, it operates the ratchet device which makes and breaks the electrical circuit. Here precision, insulation, and durability are of the utmost importance.

McGill's many years of successful experience with INSUROK brought about a complete redesigning program when brass became unavailable. Through the proper use of precision INSUROK—Molded and Laminated—McGill has developed switches of greater simplicity, compactness, ease of assembly and longer service life—not only for today, but for "tomorrow" as well.

You may find, as McGill has found, that to redesign with INSUROK Precision Plastics will improve your product. INSUROK—Laminated and Molded—is available in a wide variety of grades and types. Richardson Plasticians will be glad to help you select the type best suited to your needs. Write today for information.

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*The* RICHARDSON COMPANY

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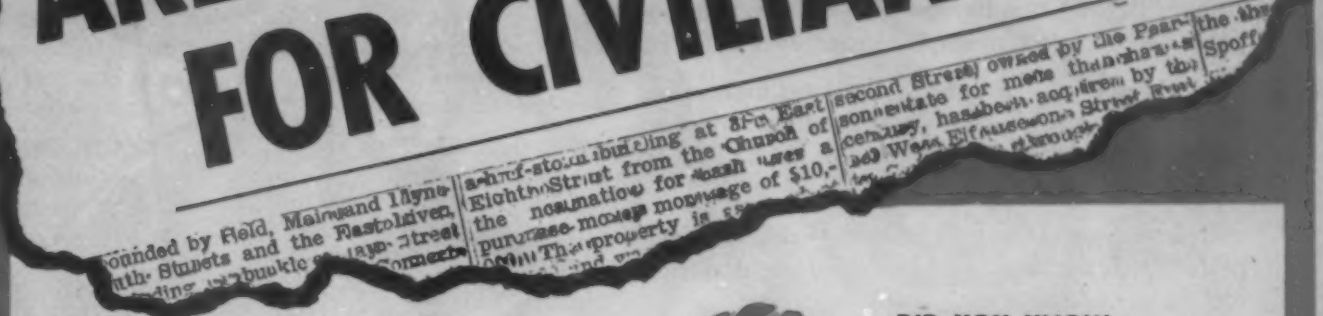
HERE'S THE NEWS YOU'VE BEEN WAITING 4 YEARS TO HEAR!

# "LUCITE" SHEETS ARE AGAIN AVAILABLE FOR CIVILIAN USE



**THE FACTS:**

For the first time since Pearl Harbor, all military requirements have decreased, *so that a considerable and increasing number of "Lucite" methyl methacrylate resin sheets are now available for civilian use.*

**DID YOU KNOW—**

that in the medium and greater thicknesses "Lucite" methyl methacrylate resin sheets now cost *less* than some other thermoplastics? There have been *five* price reductions during the war.

**ADVANTAGES OF "LUCITE"**

—need little introduction to fabricators. Crystal clarity, excellent optical properties, light weight, high impact strength, ability to be formed into extreme contours, shatter-resistance, good electrical insulation, resistance to weather and aging. These are the reasons the Army and Navy have used "Lucite" so extensively as to cause us to increase production tenfold. These are the properties that will again make peacetime products in many fields more useful, more attractive, more salable.

**DON'T DELAY.** A great number of peacetime orders are being filled. We suggest entering your needs now for filling as soon as possible. Standard cast sheets come in sizes up to 40" x 50" in thickness from .060" up. Larger sizes can be produced on special order up to 54" x 78", in thicknesses from 0.125" up. Massive castings can be produced on special order in limited sizes with thicknesses of 1½" to 10". For full information write E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, N.J.

FOR PLASTICS... CONSULT DU PONT

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

# PLASTICS . . . FOR EVERYDAY USE

Everyday use of plastic . . . .

. . . . is effectively illustrated by the injection molding of the common soap dish and tumbler holder made to high Navy specifications for ship installation.

Light weight yet sturdy—these toilet accessory articles made by E. B. Kingman, Leominster, Mass., on a Reed-Prentice 10D—8 Oz. machine (shown below) are being molded from thermoplastic materials quicker, cheaper and better!

Many post-war articles will lend themselves to mass-production by Reed-Prentice injection molding machines — available in 6, 8, 12, 16 and 22 oz. sizes.

Investigate the possibilities — ask for complete details about machines and mold design today!

Reed-Prentice 10D—8 Oz. plastic injection Molding Machine

INJECTION

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WORCESTER MACHINES MASS., U.S.A.

NEW YORK OFFICE: 75 West St., New York 6, N. Y.
CLEVELAND OFFICE: 1213 W. 3rd St., Cleveland 13, Ohio

# *Your pen is really a Monument to Plastics*

PLASTICS and the fountain pen have literally grown up together—today they represent a time-proved partnership between good product and good material. Consider what Celanese Plastics, for example, contribute to the modern pen. It's a good basic illustration of the broad functional and design possibilities of Celanese plastics for all kinds of product applications.

**IS COLOR IMPORTANT?** Celanese Plastics are unexcelled for limitless colorability . . . light shades, pastels, midnight darks, clear transparents, also beautiful configurations and mottles. Color goes clear through—combined with surface smoothness that improves with use.

**FABRICATING VERSATILITY?** You command a complete choice of economical modern methods, including rapid injection and extrusion molding; drawing and forming from sheets; machining from rods and tubes. Ideal for molding over metal because of proper ratios of expansion and contraction; especially adaptable for metal inserts.

**STRENGTH AND DURABILITY?** Celanese Plastics, being cellulosics, are outstanding for toughness. Also, have good water resistance, form retention, surface hardness and good electrical properties.

**PERSONAL APPEAL?** You instinctively like to touch things made of Celanese Plastics—they feel smooth, inviting—and never too hot nor too cold. This is one of the reasons Celanese Plastics are used in so many personal-contact articles . . . spectacle frames, bathroom accessories, handles, steering wheels, hardware—and, of course, pens and pencils.

***IN SHORT,*** Celanese Plastics are No. 1 materials for creative design and sound craftsmanship. When planning for plastics, consult the Celanese technical staff, whose up-to-date experience in both civilian and war applications is at your service. Celanese Plastics Corporation, *a division of* Celanese Corporation of America, 180 Madison Avenue, New York 16, New York.

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LUMARITH

*A Celanese Plastic*

# NO HOCUS-POCUS

There's been a lot
of Hocus-Pocus
and mystery
about Plastics.
Forget it!
We've been molding plastics
more than 100 years.
We know our business.
If you have a problem
in compression or injection
molding,
in large or small pieces,
bring it in!
You'll like our brand
of horse-sense.

## HAVE YOU A PLASTICS PROBLEM?

PROLON PLASTICS

# ..... your product can be improved with a Kimpreg* Surface

A revolutionary new alloy-like material is achieved by fusing to plywood's surface a cured plastic skin of KIMPREG. This resultant material is not a plywood in the ordinary sense, not a conventional plastic laminate. It is a brand new, better structural medium with countless applications in many products—including, very probably, those *you* plan for post-war production.

With KIMPREG, plywood is converted into an improved substance which can be machined, formed and fastened like ordinary wood—yet has a plastic's smooth, tough surface and beautiful, permanent, paintless finish.

KIMPREG adds the following advantages to plywood: 1) increases durability and flexural strength; 2) provides resistance to moisture and vapor; 3) armor-plates against extreme abrasion; 4) diminishes grain-raising effects; 5) makes the material scuffproof, splinterproof, snag-resistant; 6) affords a stainproof, washable, "wipe clean" surface; 7) creates resistance to chemical action, decay, temperature-extremes, fire, vermin, and mold. Moreover, it is warm to the touch, does not have the chill "feel" of metal surfaces.

Used for airborne "pre-fab" huts, glass-smooth tables for packing parachutes, water-proof ammunition boxes and scores of other uses, KIMPREG has distinguished itself on the vigorous proving-ground of wartime. Soon it will be offered in a variety of appealing hues.

Now is the time to investigate the possibilities of KIMPREG-surfaced materials for your *peacetime* requirements.

Write us for further information and names of those plywood manufacturers who are currently using KIMPREG plastic surfacing material.

Kimpreg
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A PRODUCT OF Kimberly Clark RESEARCH
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**Send Coupon for FREE KIMPREG Book to:**
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Firm _____

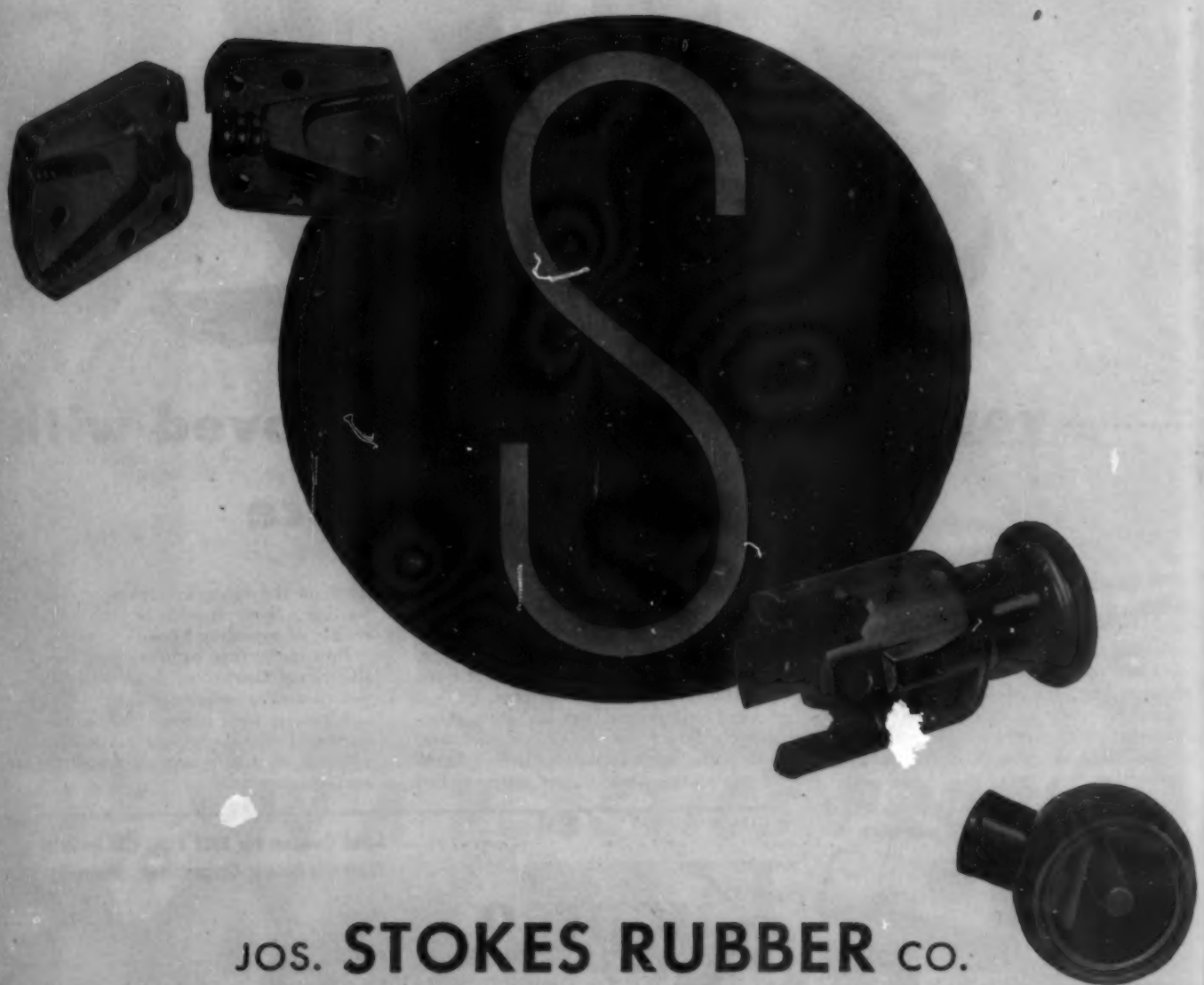
Type of Business _____

Address _____

City _____ State _____

# How Plastic is Your Planning?

**Planning for the use of plastics begins with choosing the right plastic. To guide you in this choice you have at your call the cumulative value of Stokes experience. Since 1897 Stokes has been designing and manufacturing products of plastics and hard rubber.**



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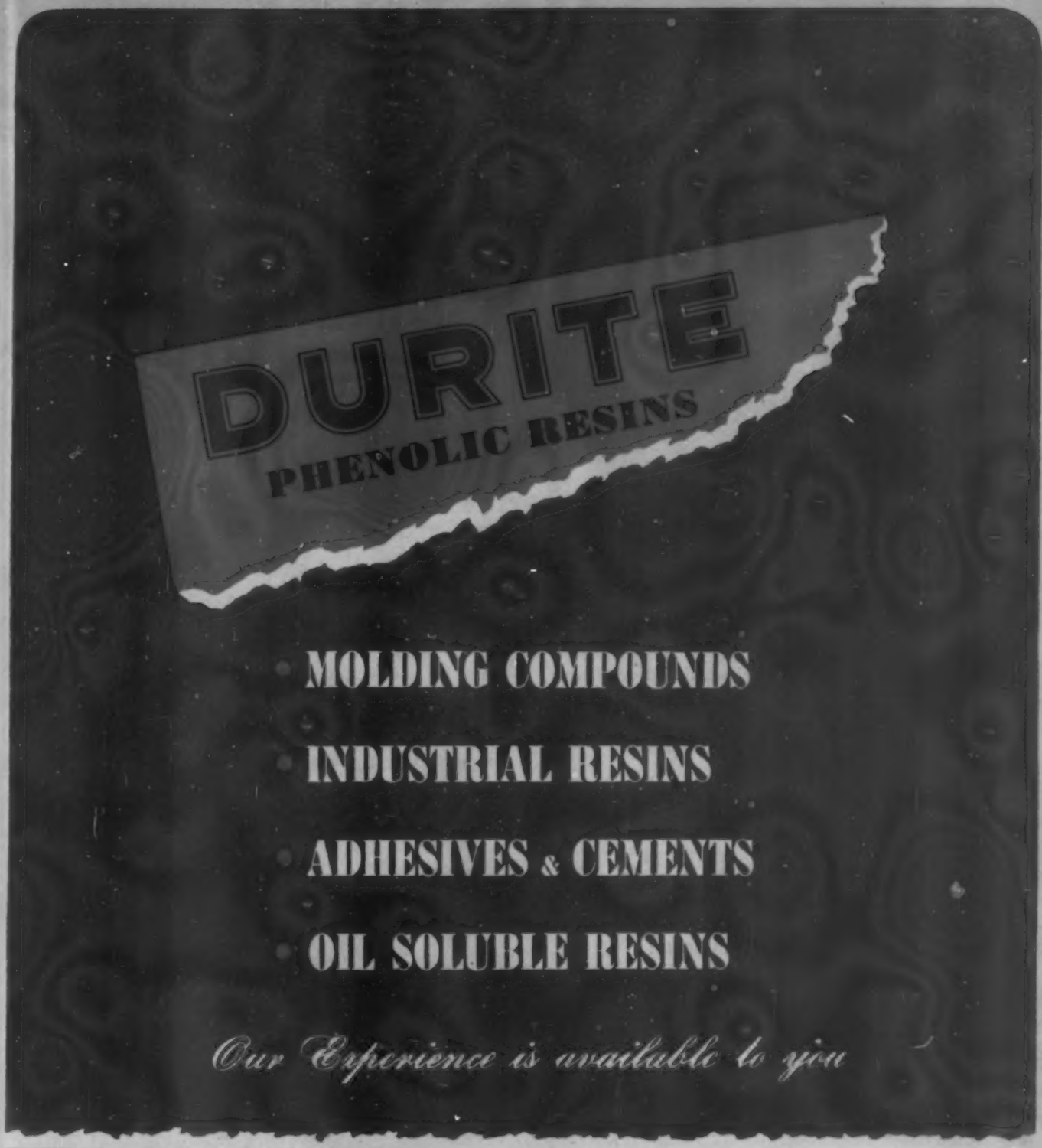
**Molders of Hard Rubber and Plastics • Since 1897**

**TRENTON, N. J.**

In Canada: Jos. **STOKES RUBBER** Co., Ltd., WELLAND, ONT.

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Take two solids . . . *any* two.

Coat the surfaces to be joined with Pliobond . . . the ONE-PART bonding agent. Join, and maintain firm pressure for 10-15 minutes. For extremely high shear strength, use moderate pressure, and heat to 200-300°F.

The result of this manufacturing arithmetic is a shockproof, permanently joined unit.

There, in short, are the revolutionary advantages of Pliobond.

It's a *one*-part bonding agent . . . no mixing. It's quick and easy to use . . . apply by spraying, brushing, spreading or roller-coating.

And it's *universal*. You can join anything to anything with Pliobond.

Manufacturing facilities for Pliobond are being increased rapidly to meet your needs. Write us for complete technical information. Be sure to include details on any special problems.

**CHECK THESE PROPERTIES OF PLIOBOND:**

**WATERPROOF** . . . continued immersion will reduce bond strength, but original value returns on drying.

**CHEMICAL RESISTANCE** . . . to dilute acids and alkalies and corrosive salt solutions.

**INSOLUBLE** . . . in gasoline and other petroleum distillates, lubricating oils, alcohol, ethylene glycol and carbon tetrachloride.

**FLEXIBILITY** . . . an important property in bonding paper, leather, thin metals, fabrics, vulcanized rubber and other non-rigids.

**DURABILITY** . . . high bond strength, waterproofness, permanent flexibility, temperature resistance and immunity to attack by mildew and fungi mean durability.

**NEVER BEFORE**

An Adhesive That Bonds

**SO QUICKLY!**
**SO EASILY!**
**SO STRONGLY!**

Take a good look at this picture. *All* of these so different materials, perfectly bonded by one agent . . . Pliobond!

*Pliobond* **BONDS ANYTHING TO ANYTHING!**

## UNITED STATES PLYWOOD CORPORATION . . . Exclusive Distributors

*Industrial Adhesives Division: 55 West 44th Street, New York, N. Y. · Branches in Principal Cities*

*PLIOBOND® is a product of* THE GOODYEAR TIRE & RUBBER COMPANY · ®Trademark registered, The Goodyear Tire & Rubber Company

# *Special formulations* FOR SPECIFIC NEEDS!

# Fibron

## PLASTIC EXTRUSIONS AND TAPES

Users of flexible plastic extrusions or plastic tape secure a large increment of efficiency and economy when they specify "Fibron by Irvington." For the product they receive has been especially formulated for their own specific need. Should the *major* requirement be operation at elevated temperatures, a Fibron formulation for exactly that job can be supplied. Likewise for temperatures as low as −70°F; or for services requiring resistance to acids, alkalis, corrosive fumes, and abrasion. In each case the correct Fibron formulation is supplied.

It is this Irvington policy of "*engineering* and *formulating* for specific applications," that accounts for the long service which Fibron plastic products provide . . . under many varied and difficult conditions.

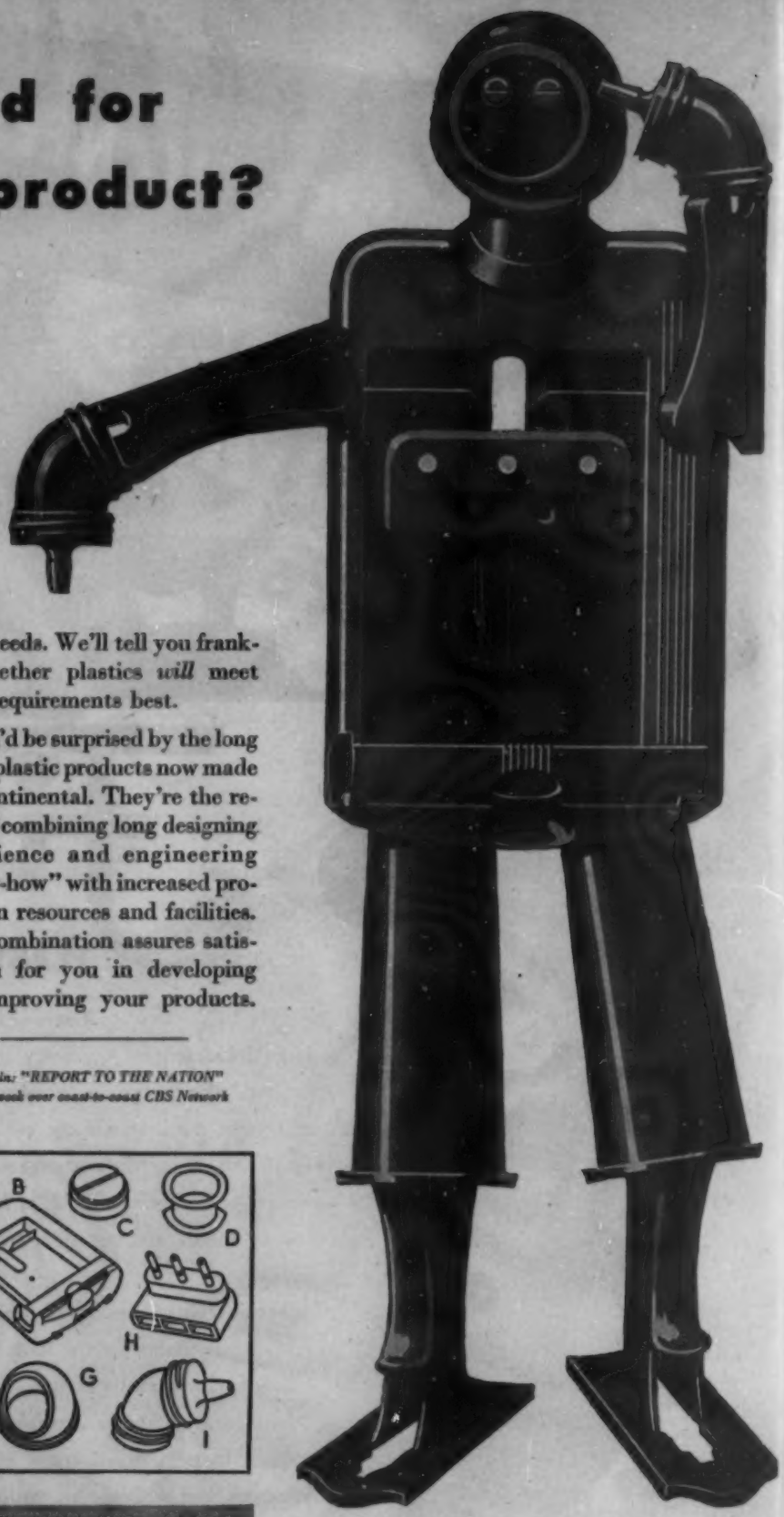
Fibron flexible plastic extrusions can be manufactured to meet your requirements for shape, size and color; Fibron plastic tapes in a wide variety of colors, thicknesses and widths. An outline of your special requirements will receive immediate attention. Write Dept. 146.

**IRVINGTON**
**VARNISH & INSULATOR CO.**
**Irvington 11, New Jersey, U. S. A.**

"LOOK TO IRVINGTON FOR CONTINUED LEADERSHIP IN INSULATION"

# Diving around for a better product?

*(Can you name the plastic parts that make up this diver? See chart below.)*



**If you're** really going overboard to develop better products, take some useful tips from this diver.

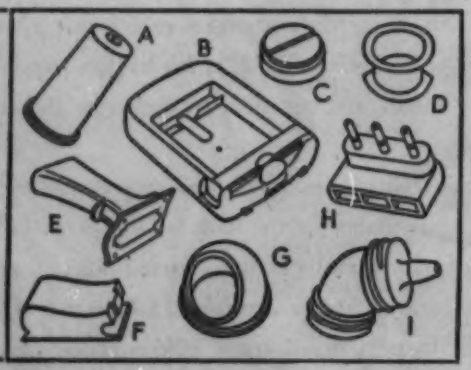
He's made from nine different plastic products, all manufactured in Continental Can Company's plastics plant at Cambridge, Ohio. Our diver's body is a billing machine housing; his legs, two sales-ticket holders; his feet, two loudspeaker trigger handles; his head, a mouthpiece.

This diver shows that plastics are ideal for certain uses and our designing and engineering departments will be glad to analyze your needs. We'll tell you frankly whether plastics *will* meet your requirements best.

You'd be surprised by the long list of plastic products now made by Continental. They're the result of combining long designing experience and engineering "know-how" with increased production resources and facilities. This combination assures satisfaction for you in developing and improving your products.

*Tune in: "REPORT TO THE NATION" every week over coast-to-coast CBS Network*

(A) Mouthpiece; (B) Brush cap for motor; (C) Collar; (D) Billing machine housing; (E) Terminal connector; (F) Trigger for gun handle; (G) Nozzle for intravenous bottle; (H) Sales-ticket holder; (I) Loudspeaker trigger handle—all made by compression process.




CONTINENTAL CAN COMPANY, INC.

PLASTICS DIVISION

HEADQUARTERS: Cambridge, Ohio

Sales Representatives in all Principal Cities

COMPRESSION • INJECTION • EXTRUSION
SHEET FORMING • LAMINATION

**OTHER CONTINENTAL PRODUCTS:** Metal Containers • Fibre Drums • Paper Cups • Plastic Products • Crown Caps and Cork Products • Machinery and Equipment.

# ...can you use this *Plexiglas* movie?

These scenes are from the sound film produced by Rohm & Haas on the maintenance and repair of PLEXIGLAS. ¶ It's an interesting and educational semi-technical film that has been widely shown at Army Air Force bases as an aid to ground instruction. ¶ Now that the war is over, this 16-millimeter film is available for civilian uses. Members of the plastics industry and educational institutions may borrow a print with no obligation by writing to Rohm & Haas Company, Washington Square, Philadelphia 5, Pa. Please give your first and second choice of dates and the approximate length of time you expect to use it.

ONLY ROHM & HAAS MAKES *Plexiglas* CRYSTAL-CLEAR ACRYLIC SHEETS AND MOLDING POWDERS

*PLEXIGLAS is the trade-mark, Reg. U. S. Pat. Off.*

ROHM & HAAS COMPANY

*WASHINGTON SQUARE, PHILADELPHIA 5, PA.*

Manufacturers of Chemicals including Plastics . . Synthetic Insecticides . . Fungicides . . Enzymes . . Chemicals for the Leather, Textile and other Industries

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REGISTERED TRADE MARK

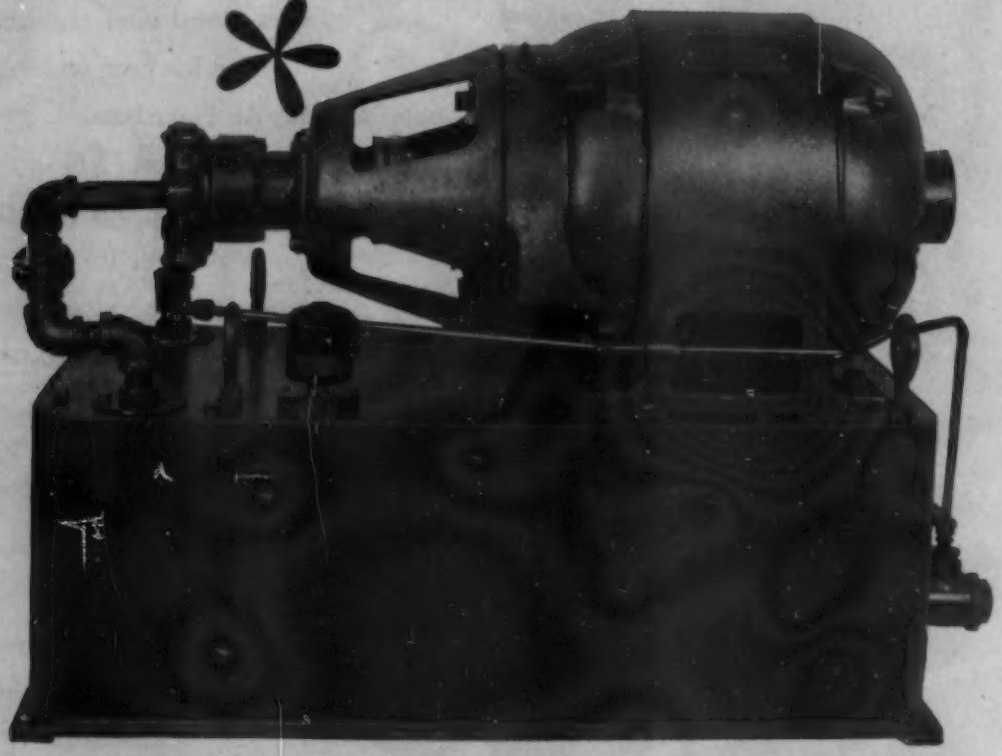
*The wide field of use is illustrated by the list of applications shown below where these compact units have displaced manual and mechanical equipment.*

TEXTILE FINISHING ROLLS • STEEL ROLL MILLS
BRASS ROLL MILLS • SCALE BREAKER ROLLS
STARTING TORQUE RELIEF • DIE CLAMPS
PRODUCTION PRESSES • LABORATORY
PRESSES • HYDROSTATIC TESTS • AUTO-
CLAVE PRESSURE SEALS • BEARING
FLOTATION • HIGH PRESSURE CLOSING
AND DWELL

## *Automatic*
## Hydraulic Pressure

•

| | | |
|---|---|---|
| 1.2 GPM | 3000 p.s.i. Continuous | 33″x 15″x 13″ High |
| 2.4 GPM | 3000 p.s.i. Continuous | 33″x 16″x 24″ High |



**To provide for a wider range of automatic control, the basic units can be furnished with accessory equipment including accumulators, pressure switches, pressure metering valves, manual or solenoid operating valves.**

**For operations requiring large prefill capacities, comparable units are built with two-pump combinations to provide high volume, low pressure, and high pressure closing and dwell cycles.**

*Write today for detailed information*

**EXPERIENCED HYDRAULIC ENGINEERING SERVICE IS AVAILABLE**

•

**THE NEW YORK AIR BRAKE COMPANY**

*Hydraulic Division*

420 LEXINGTON AVENUE, NEW YORK 17, N. Y. FACTORIES: WATERTOWN, N. Y.

# PANELYTE ADDS 60,000 MORE SQ. FT. OF MODERN FABRICATING SPACE

Exterior view of new Fabricating Plant at Trenton, N. J.

WE *want* to be modest . . . but when you are moving into the newest, most modern fabricating plant in the *whole* laminated plastics industry you can't help being *enthusiastic.*

For the War effort Panelyte has produced large *volumes* of intricately fabricated parts . . . has earned and held Army-Navy E awards . . . has been assigned an "Approved" Quality Control Rating by the Air Technical Service Command.

The addition of new machinery and machine tools to our existing inventory of equipment will enable us to handle *any type* of fabricating operation. *Deliveries on schedule* regardless of quantity involved is *one* of the reasons for the increased business which necessitated, in turn, this factory expansion.

Get in touch with our nearest office, or write for factual, comprehensive "Engineering Data Book."

**PANELYTE** *the structural plastic*

PANELYTE DIVISION
ST. REGIS PAPER COMPANY
230 PARK AVENUE
NEW YORK 17, N. Y.

★ **MASS PRODUCTION OF SHEETS, RODS, TUBES, MOLDED FORMS, FABRICATED PARTS IN PAPER, FABRIC, FIBRE GLASS, WOOD VENEER AND ASBESTOS BASE LAMINATES**

**Sales Offices: Atlanta, Boston, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Kansas City, Los Angeles, Nashville, New Orleans, Phoenix, Portland, St. Louis, St. Paul, San Francisco, Seattle, Syracuse, Trenton: Buenos Aires, Johannesburg, Mexico City, Montreal, Sao Paulo, Toronto, Vancouver.**

# Readily Molded to Any Shape . . .

## The "Skycycle"

Latest development of the Piper Aircraft Corporation, Lock Haven, Pa. Its developers hope that this plane may become the bicycle of the air. The present test model employs Co-Ro-Lite for the forward section of the fuselage. Future models will find Co-Ro-Lite molded into a complete fuselage, the leading edge of the wings, and wing tips. Co-Ro-Lite is also being considered for all moving controls.

# CO-RO-LITE*

## the rope fibre plastic

. . . a ready-to-mold thermosetting plastic compound, is adaptable to fluid transfer molding. Long, tough, interlocking rope fibres reenforce all sections of the molded unit, imparting great impact, flexural, compressive, and tensile strength in a range of densities comparable to wood. Provides marked economies in mold manufacture, lay-up and curing time.

*CO-RO-LITE:—Rope fibres impregnated with thermo-responsive resin:—Product and process patented — Patents No. 2,249,888 and No. 2,372,433 — other patents pending.

ARMY E NAVY

ALLIED PRODUCTS DIVISION

**COLUMBIAN ROPE COMPANY**

460-92 Genesee St., Auburn, "The Cordage City," N. Y.

Canadian Licensee: Canadian Bridge Engineering Company, Ltd.
Box 157, Walkerville, Ontario, Canada

# Beauty and Utility

## IN PLASTICS and METALS

Important to all designers is the fact that plastics, metals, and plastic-metal combinations are being produced entirely under one roof by the Bay Manufacturing Division of Auto-Lite. Such examples as this Fifth Avenue Medallion, a finely designed plastic casting mounted on a chrome-plated and decorative bezel . . . the vinylite plastic grommet and nipples (vinylite does not require the heavy walls of rubber products) . . . the etched enamel-filled high polished chrome escutcheon . . . typify fine Auto-Lite craftsmanship.

**THE ELECTRIC AUTO-LITE COMPANY**

Detroit 2, Mich. Bay Manufacturing Division Bay City, Mich.

UNDER ONE BIG ROOF AT . . .

# Auto-Lite

Tune in "Everything for the Boys" Starring Dick Haymes Every Tuesday Night — NBC Network

BUY WAR BONDS

Quiet

Design engineers looking for peak efficiency and long life in fractional H.P. motors, will pick a QUIET motor—A BALLENTINE MOTOR. Because only skilled craftsmanship, strict adherence to close tolerances, *precision dynamic balance* plus modern manufacturing methods and equipment can produce a truly QUIET motor. In BALLENTINE MOTORS, the engineer finds all these factors—*at their best*—combined with suitable mechanical and electrical design. *Quiet* BALLENTINE MOTORS are available in ratings from 1/1000 to 1/6 H.P.—adapted to your specific application. Write for descriptive bulletin.

**BALLENTINE MOTORS**

*Manufactured by*

**RUSSELL ELECTRIC COMPANY**

352 W. HURON STREET, CHICAGO 10, ILLINOIS

# GLASS *from Custard Cups*

## *To* SEALED BEAM HEADLIGHTS

The first experimental models of sealed beam headlights were made from PYREX custard cups. From these first crude models was evolved the new and more practical headlight which received the immediate, enthusiastic acceptance of the automobile industry.

Corning did not originate the idea of the sealed beam headlight, but Corning was able to supply valuable assistance in perfecting the idea.

Corning's contribution included a glass composition with properties balanced to meet the specific service requirements; collaboration on the design of the product; and adaptation of facilities to provide fully automatic, economical production.

Corning research has developed thousands of different glass compositions—each possessing the valuable properties of glass, in countless combinations and in a wide range of values. Vast experience in designing many types of glassware enables Corning design engineers to provide valuable design assistance. The comprehensive fabricating facilities of Corning—from hand operations to mass production machinery—make possible economical production of quality glassware in almost any required quantity.

These are the services Corning is prepared to offer to make your new product and redesigning ideas become realities. Write today to the Industrial Sales Dept., PE-9, Corning, New York. Your inquiry will receive prompt attention.

*"PYREX" and "CORNING" are registered trade-marks and indicate manufacture by Corning Glass Works, Corning, New York.*

GLASS by CORNING

MARKS AND INDICATE MANUFACTURE BY CORNING GLASS WORKS, CORNING, N.Y.

Industrial Sales Dept., MP-10
Corning Glass Works, Corning, New York

Please send me a copy of your Bulletin 842—
*"Industrial Glass by Corning."*

Name_____ Title_____

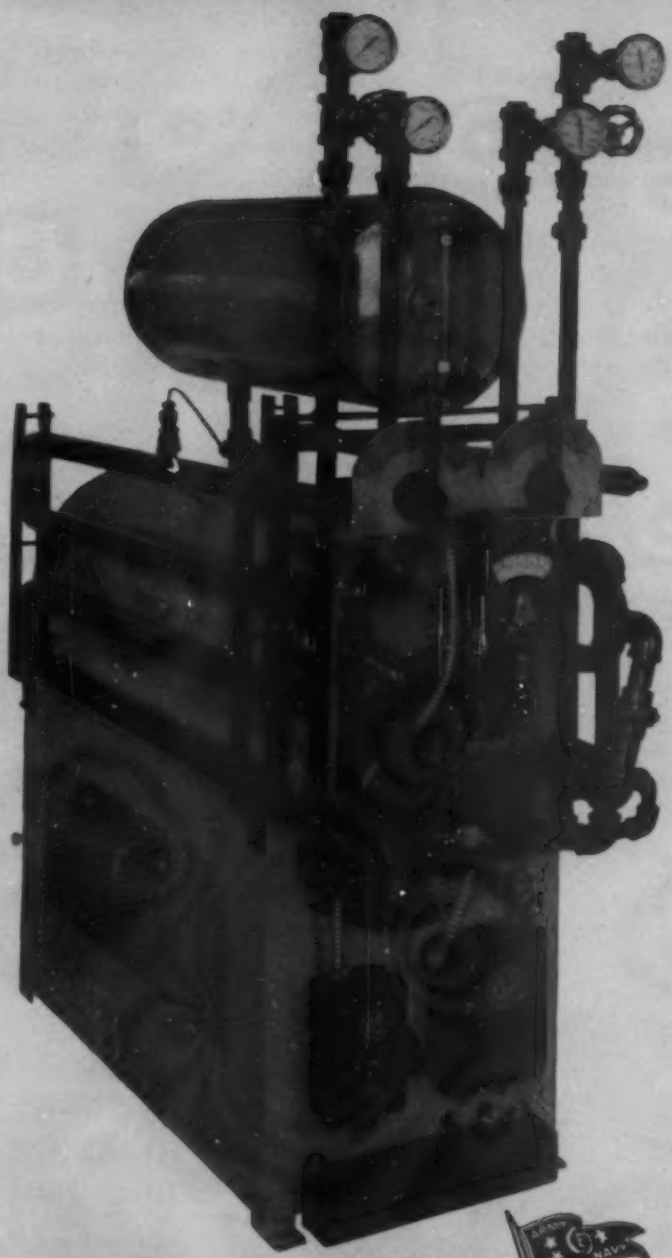
Firm_____

Street_____

City and State_____

# Extruder Temperature Control Unit

- Wide temperature range available
- Sustains high or low extruding temperatures
- Supplies or removes heat from extruder as required
- Multiple circuits can be accommodated
- Hand lever selection of pre-determined extruding temperatures
- Available in two sizes
- Compact



## JOHN ROYLE & SONS

ROYLE PATERSON N. J. 1880

PIONEERED THE CONTINUOUS EXTRUSION PROCESS IN

James Day (Machinery) Ltd.
London, England
REgent 2430

Home Office
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Akron, Ohio
J. C. Clinefelter
UNiversity 3726

PATERSON 3, NEW JERSEY

## We are proud of the part we had in the development of

### THE AMAZING NEW

# SONOTONE 600

THE one-piece metal chassis and the plastic parts, pictured to the right of the Sonotone 600 above, are the products of Lance "complete metal-plastics facilities" from start to finish. This triumph of scientific research . . . the Sonotone 600 . . . of necessity demanded design and production within tolerances not usually encountered. That we were entrusted with the difficult task of building the dies and molds to produce these extremely accurate parts, and are continuing to meet the stiff demands of Sonotone production, makes us justly proud.

*Complete*
**METAL-PLASTICS**
*Facilities*

***We'd be glad to talk over some of your difficult metal-plastics problems . . . together we can probably cook up the correct solution.***

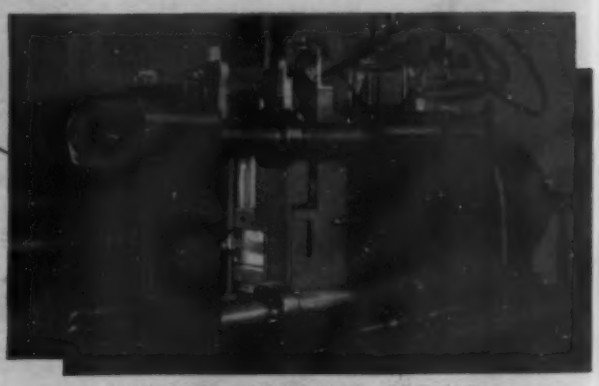
**LANCE** Manufacturing Company

FIFTH and COURTLAND STREETS • PHILADELPHIA 40, PENNA.

Santay

SYMBOL OF PRECISION CRAFTSMANSHIP

CORRECT MATERIALS



PROPER MOLDING SET-UP

# Molding Technique

Finished products by SANTAY incorporate exclusive and intricate technique gained through a quarter century of intensive specialization. 1. Here, the determination of *correct materials* together with methods of preparation and handling are reduced to an exact *science;* 2. Set-up of *tools* and *presses* include unique procedures which result in vastly improved injection molding; 3. Santay operators . . trained to an unusual degree . . work under the constant supervision of our skilled engineers; and, 4. Finishing becomes a fine art, performed according to methods specially engineered and developed by the Santay capable research staff.

Whenever a really fine thermoplastic product becomes an essential requirement, remember Santay's superlative molding technique.

TRAINED OPERATORS

BETTER FINISHING

INJECTION MOLDING • METAL STAMPING • ELECTRO-MECHANICAL ASSEMBLIES

SANTAY CORPORATION

355 NORTH CRAWFORD AVENUE • CHICAGO 24, ILLINOIS

REPRESENTATIVES: POTTER & DUGAN, INC. 29 WILKESON STREET, BUFFALO 2 • PAUL SEILER, 7770 CLEVELAND AVENUE, DETROIT 4 • QUEISSER BROS. 115 E. NINTH STREET, INDIANAPOLIS 2

# THE SHAPE OF THINGS THAT *AREN'T* TO *COME!*

*They're here now . . . to Help You with Design and Production of New Products*

THESE shapes—and more besides—are being made every day by scores of forward-thinking manufacturers. For plastics extrusion is a *proven,* highly effective method of producing plastic parts *quickly, easily* and at *low cost.*

Practically any continuous shape you want can be extruded. These extrusions may be cut into sections, bent, stamped, or punched to give even greater variety of form. *Think* of the vast new possibilities plastics extrusion may open for your new products!

By designing for extruded parts in your products *now,* you may save on production cost, time, or labor. Your product can achieve greater smartness of style, more durability, increased consumer appeal. No wonder manufacturers in every type of industry planning for new product development, are planning on plastics extrusion for fabrication.

Learn more about the application of plastics extrusion and the equipment for production of *your* new product. Write National Rubber Machinery Company, Akron 11, Ohio.

NATIONAL RUBBER MACHINERY CO.
General Offices: Akron 11, O.

Plastics
MACHINERY DIVISION

# Why Glycerine is a SUPERIOR PLASTICIZER

GLYCERINE *solutions* do not differ markedly from glycerine itself in plasticizing action on hydrophillic (water-absorbing) materials. Glycerine absorbs moisture from the air, and the result is an increased weight of glycerine solution, which is distributed throughout the material in which it is used. This happens in tobacco, leather, cellophane, adhesives—or any of hundreds of other materials in which glycerine is used as a humectant-plasticizer. Actually, when glycerine is added to a product, its effect is to give the benefit of up to *three times its weight of plasticizer.*

In addition, glycerine's low vapor pressure, high sweetening power, value as a food, wholesomeness, emolliency, solvent power—all these advantages, plus many others, make glycerine the ideal humectant-plasticizer in many fields.

Crystal-clear C.P. glycerine is safe and dependable. Specify glycerine in the making of your products—now, and in the future.

**GLYCERINE PRODUCERS' ASSOCIATION**

**295 Madison Avenue, New York 17, N. Y.**

*Research Laboratories: Chicago, Ill.*

**In Foods!** A food in itself, utilizable by the body as a carbohydrate, and with high sweetening power, glycerine is a standby in making flavorings, confections, soft drinks—and many other foods and food products.

**In Textiles!** Solvent power, low freezing point, high boiling point, miscibility with both water and alcohol, and excellent lubricating and softening powers, are among the reasons why glycerine is used in processing textiles.

**In Resins!** Glycerine is one of the important components in the making of alkyd resins. These resins make possible many useful textile finishes—as well as a wider range of paints or surface coatings.

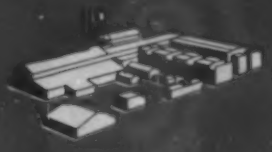
**In Cosmetics!** C.P. glycerine's wholesomeness, emollient properties, resistance to evaporation, solvent power, and compatibility, make it ideal for use in many cosmetics.

**In Food Packaging!** Transparent wrappings that come into contact with foods are made through the use of glycerine—because it is wholesome. Glycerine helps assure you satisfied customers.

# UNITED

*in Research · Engineering · Production*

## 2 GREAT ORGANIZATIONS · 6 GREAT PLANTS

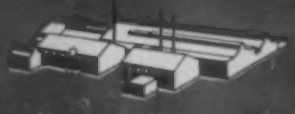


PITTSBURGH

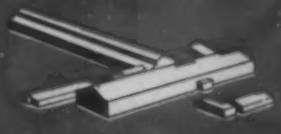
VANDERGRIFT

NEW CASTLE

YOUNGSTOWN



CANTON



AKRON

*Serving the Metal Processing Industry*

## UNITED ENGINEERING AND FOUNDRY CO.

*The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment*

### TYPICAL PRODUCTS MANUFACTURED BY UNITED

**ROLLING MILLS**

Blooming · Slabbing · Plate · Universal 2, 3, 4-high · 4-high Hot Strip · Bar Rail and Structural · Merchant Rod · Sheet · Skelp · Pipe and Tube · 2 and 4-high Cold Strip · Tin · Unitemper

*In all types:* Single Stand, One Way or Reversing, Tandem, Continuous, etc. For Carbon Steel, Alloy Steels, Copper, Brass, Aluminum and other Non-Ferrous Metals.

**ROLLS**

"UNEFCO" Green Wabblers, Grain and Chill United Nickel Chill · United Moly. Chill · United Spec. Process · UX Chill and Grain · H.D. Spec. Process Lincoln Special United Unidense United Special Steel · United Carbon Steel · United Adamite · United VAN-X · United Super X · United Straight Chill.

**AUXILIARY EQUIPMENT**

Ingot Cars
Manipulators
Edgers
Mill Tables
Transfers
Hot Beds
Structural Straighteners
Bloom Shears
Vertical Shears
Hot and Cold Saws
Rod Reels
Hot Strip Reels
Flying Shears
Shearing Lines
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UNIDRAW—Continuous Draw Benches
Steam Hydraulic Forging Presses
Electro-Hydraulic Forging Presses
Electro-Hydraulic Piercing Presses
Hydraulic Presses
Universal Couplings
Welding Manipulators
Plate and Squaring Shears
Precision Levellers
Cone Type Uncoilers
Coil Boxes
Upcoilers & Downcoilers (Strip)
Cold Strip Reels
Cone Worm Drives
Gear Reduction Units
Generated Gears and Pinions
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Annealing Boxes
Steel Castings

*Serving the Rubber, Plastics and Plywood Industries*

## ADAMSON UNITED COMPANY *

*Subsidiary of United Engineering & Foundry Co.*

### TYPICAL PRODUCTS MANUFACTURED BY ADAMSON UNITED

Mills
Refiners
Crackers
Mixers
Washers
Calenders
Tubing Machines
Large Molds
Pot Heaters
Vulcanizers
Autoclaves
Hydraulic Presses
Multi-Platen Presses
Automatic Curing Presses
Belt Curing Presses
Compression Molding Presses
Plywood Presses
Auxiliary Equipment

*Formerly ADAMSON MACHINE CO., Akron, Ohio

Recent acquisition, by UNITED ENGINEERING and FOUNDRY COMPANY, of ADAMSON UNITED COMPANY, combines the experience and capacities of two great research, engineering, and manufacturing organizations in a wide field of service to processors of metals, rubber, plastics and plywood.

The *united* resources and abilities of these two internationally known companies, both leaders in their respective fields for over 30 years, offer unusual advantages to industries interested in the development of new processes and equipment for present or postwar expansion.

We invite you to consult us while your plans are still in the blueprint stage.

## UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

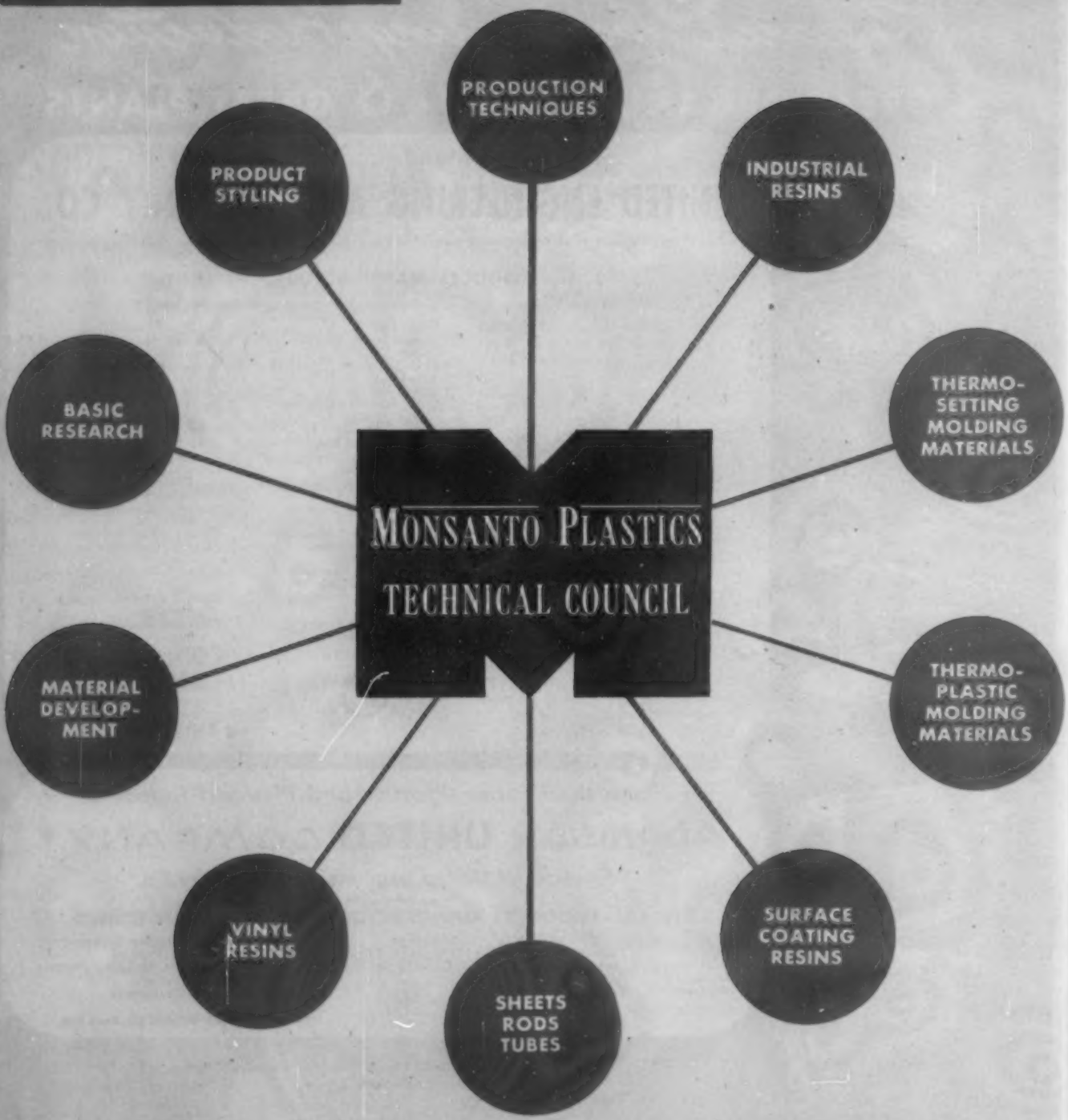
Plants at Pittsburgh · Vandergrift · New Castle · Youngstown · Canton

Subsidiary: Adamson United Company, Akron, Ohio

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England

Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

# a new idea


PRODUCTION TECHNIQUES
PRODUCT STYLING
INDUSTRIAL RESINS
BASIC RESEARCH
THERMO-SETTING MOLDING MATERIALS
MONSANTO PLASTICS TECHNICAL COUNCIL
MATERIAL DEVELOP-MENT
THERMO-PLASTIC MOLDING MATERIALS
VINYL RESINS
SURFACE COATING RESINS
SHEETS RODS TUBES

# get the answer to your plastics problem from this group of experts

**Ten heads are better than one.**
That's why we invite you to put your plastics problem up to this group of ten picked plastics experts... each one a highly qualified representative of a different major phase of plastics practice.

Your problem, whether it concerns plastics materials, methods, designs or costs, will undergo the thorough analysis of this entire group, representing a combined experience of more than a hundred years in this young industry.

You will receive a written recommendation, practical and comprehensive, bearing the seal of Monsanto Plastics Technical Council . . . your assurance of sound unbiased advice.

**How to Get Your Problem before the Council.**
Manufacturers, molders or fabricators—anyone who would like to receive this free consultative service need only write describing in full his particular problem. The information needed by the Council is outlined in a bulletin describing the Council and its functions.

The Council meets regularly in Monsanto's Springfield, Massachusetts conference room. Address all requests for the bulletin or information to: MONSANTO PLASTICS TECHNICAL COUNCIL, MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

The broad and versatile family of Monsanto Plastics includes: Lustron* polystyrene • Cerex* heat resistant thermoplastics • Vinyl acetals • Nitron* cellulose nitrates • Fibestos* cellulose acetates Resinox* phenolics • Thalid* for impression molding • Resimene* melamines • Forms in which they are supplied include: Sheets Rods • Tubes • Molding Compounds • Industrial Resins • Coating Compounds • Vuepak* rigid, transparent packaging materials. *Reg. U. S. Pat. Off.

MONSANTO PLASTICS

SERVING INDUSTRY... WHICH SERVES MANKIND

# Strip

*a wartime technique!*

*The new way to package and protect*

## Apply it • Dry it • Store it • Ship it • *Strip* it!

Another invaluable war tool is now available. CORDO-FLEX is a synthetic plastic coating, *applied cold*, by spray, dip or brush. It air-dries in a few minutes; forms a perfect seal against water, oil and gasoline; protects surfaces against corrosion, abrasion, handling, harmful elements and the weather, while in storage or in transit.

In clear and in colors, CORDO-FLEX presents a war-proved method of packaging for protection, preservation and identification. Please write for complete data, explaining any proposed applications, for specific recommendations.

**other CORDO products**

CORDO-BOND • Industrial Adhesives
CORDO-CLAD • Plastic Metal Coatings
CO-RES-CO • Maintenance Coating
CORDO CLOTH COATINGS • Plastic Surfacing for Textiles

**CORDO-CHEMICAL CORPORATION**
34 Smith Street
Norwalk, Connecticut

# CORDO-FLEX

TAKE a good look at this beautiful Cory Coffee Brewer. Notice its unusually attractive appearance ...its natural sales appeal. No wonder it's fast becoming one of the hottest items on the market today. It's a designer's dream come true.

Like most products that are being successfully merchandised in the highly competitive consumer markets of today, the Cory Coffee Brewer makes skillful use of plastics. The hinged decanter cover, safety upper glass stand, easy-grip handle, and measuring cup are all custom molded plastic parts...custom molded by Norton.

As pioneers in the plastics molding field, Norton's design engineers have the necessary background to render unusually competent service to the manufacturer with a molding problem. In addition, Norton's large facilities for injection and compression molding are capable of inexpensively and efficiently handling practically any plastic molding job —large or small.

Bring your plastic molding problems to a company with a proved record for successful product development service...Norton Laboratories, Inc., Lockport, New York.

**NORTON** *Laboratories, Inc.*

**COMPRESSION AND INJECTION MOLDING**

In one production test, workmen turned out 20% more pieces with an experimental 6-cavity mold than were turned out with a standard 24-cavity compression mold. Mold savings in this instance were estimated at $6000. In addition, the precise extrusion eliminated flash and sprue, and produced a saving of 12½% in plastics material.

Other savings and advantages revealed by the production performance of the equipment are: (1) reduction of initial investment through use of a smaller press; (2) less wear on molds, permitting use of more easily hobbed materials, and extending mold life; (3) considerable reduction in finishing.

These results are convincing evidence of the possibilities of this new process. Baldwin engineers will be glad to work with you, in developing practical applications to your production needs. If you would like a complete story of the new press, ask for Bulletin No. 221. The Baldwin Locomotive Works, Baldwin Southwark Division, Philadelphia 42, Pa., U. S. A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston, Pittsburgh, Detroit.

BLW THE BALDWIN GROUP

**BALDWIN**

**HYDRAULIC PRESSES**

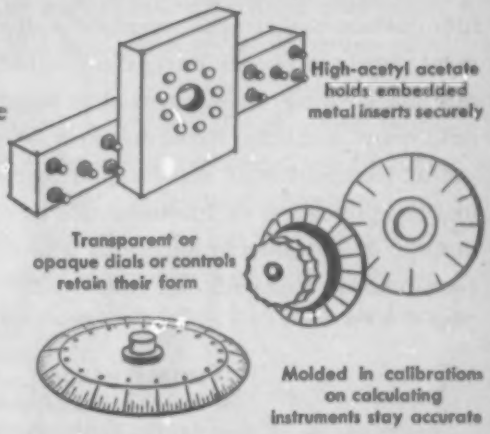
# ACCURATE AT -58° OR +158°F...

## permanent precision for postwar instrument parts or drawing implements

This propeller protractor, with finely spaced calibrations *molded in*, is an outstanding example of the dimensional stability of high-acetyl cellulose acetate. Used by ground crews to synchronize the pitch of plane propellers within ½°, it must function over a temperature range of −58° to +158°F.

High-acetyl acetate (Lumarith X), selected by Cruver Mfg. Co. after this molder had tested many plastics, added remarkable impact strength to the stability achieved. Accidentally dropped 60 ft. to a cement floor, one of these instruments suffered no damage of the plastic parts.

If you have a problem of producing similar parts to precision tolerances *on a mass production basis*, investigate the cellulosics *now*.


High-acetyl acetate holds embedded metal inserts securely
Transparent or opaque dials or controls retain their form
Molded in calibrations on calculating instruments stay accurate

**HERCULES**

**CELLULOSE ACETATE**
**CELLULOSE NITRATE**
**ETHYL CELLULOSE**

*For general-purpose production plastics*

Hercules does not make plastics or molding powder, but supplies the high-quality cellulose derivatives from which they are made. For data, please write

HERCULES POWDER COMPANY INCORPORATED 916 Market Street, Wilmington 99, Delaware.

# *Designing* with Luminescent Plastics

Under normal lighting — Under "black" light

More comfortable, less tiring night driving may be provided by luminescent dials and controls under "black" light excitation.

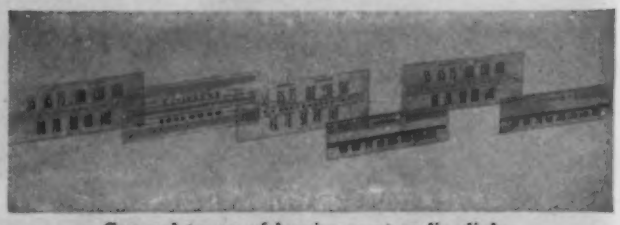
## HORSE HEAD* Luminescent Plastics for Instrument Panel Illumination

**HORSE HEAD*** Luminescent Pigments have been employed extensively with "black" light to illuminate the cockpit dials and controls of combat planes. Such a system provides pilots with good night visibility with no impairment of dark adapted eye, no windshield images that may obstruct vision, and less eye fatigue.

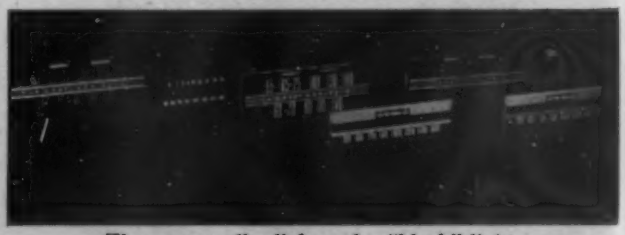
The success of the fluorescent—"black" light system of illumination suggests that eventually all automobile instrument panels will be similarly illuminated. In addition horn buttons, steering wheels, gear shift handles, switch plates, road maps, and other items also may be made luminescent.

Our technical staff will be glad to cooperate with you in the application of luminescence to the postwar automobile, or on other applications where HORSE HEAD* Luminescent Pigments are indicated.

*Reg. U. S. Pat. Off.



Several types of luminescent radio dials.



The same radio dials under "black" light.

Phosphorescent plastic articles are easy to find in the dark—aid safety of movement.

●

*Write for list of suggested civilian uses for luminescent plastics.*

**HORSE HEAD*** Luminescent Pigments have been incorporated in plastic sheets—cast, block-pressed and calendered. Molding compounds carrying these pigments in acrylic, polystyrene, cellulose acetate and urea-formaldehyde resins also have been prepared. Producers of these luminescent plastics are ready to consider inquiries from designers, users and fabricators. Their names on request.

HORSE HEAD PRODUCTS
New Jersey Zinc

**THE NEW JERSEY ZINC CO.,** 160 Front Street, New York 7, N. Y.

*Products Distributed by* THE NEW JERSEY ZINC SALES COMPANY

NEW YORK • CHICAGO • CLEVELAND SAN FRANCISCO

# SOMETHING NEW AND BETTER IN ELECTRICAL INSULATION

RECENT laboratory accomplishments have made possible new grades of Formica laminated plastics that have many qualities that were not before available in combination in any one material.

The development of new materials—glass cloth and glass mat fibre bases, and Melamine resins—have made this possible.

Among these new grades are varieties that stand more heat and more arcing than laminated material would take before. Others provide greater mechanical strength. And some are more efficient insulators of high frequency currents, approaching ceramics in that regard, but providing strength and vibration resistance for parts that must perform important structural functions.

As all of these grades are free from cellulose they resist fungus growth. Water absorption is low and does not affect either stability of dimensions or stability of electrical characteristics.

All grades are machinable—adapted to quick efficient production methods. Engineering details on request.

**THE FORMICA INSULATION COMPANY**
**4673 Spring Grove Avenue • Cincinnati 32, Ohio**

A COMPLETE TESTING PROGRAM ON

# *Plastics, Coated and Laminated Fabrics*

BACKED BY 65 YEARS OF
TEXTILE TESTING EXPERIENCE

**Plastics, coated and laminated fabrics are assuming great importance in many branches of industry . . . they are continually being introduced to new fields. Their success may depend upon any one of a dozen factors of serviceability . . . all of which are an open book to scientific Testing. The United States Testing Company, Inc., offers a unique Testing Program on plastics, coated and laminated fabrics, which combines our 65 years of textile Testing experience with our intensive work in plastic Testing.**

**Tests on plastics for furniture, shoes, building materials and household goods cover:**

Electrical Characteristics • Tensile Strength • Flexural Strength
Impact Strength • Compressive Strength • Abrasion • Resistance to
Acids and Alkalies • Heat Resistance • Resistance to Cracking
Thermal Insulating Qualities

**Tests on light plastic coated fabrics for raincoats, umbrellas, shower curtains, and similar products cover:**

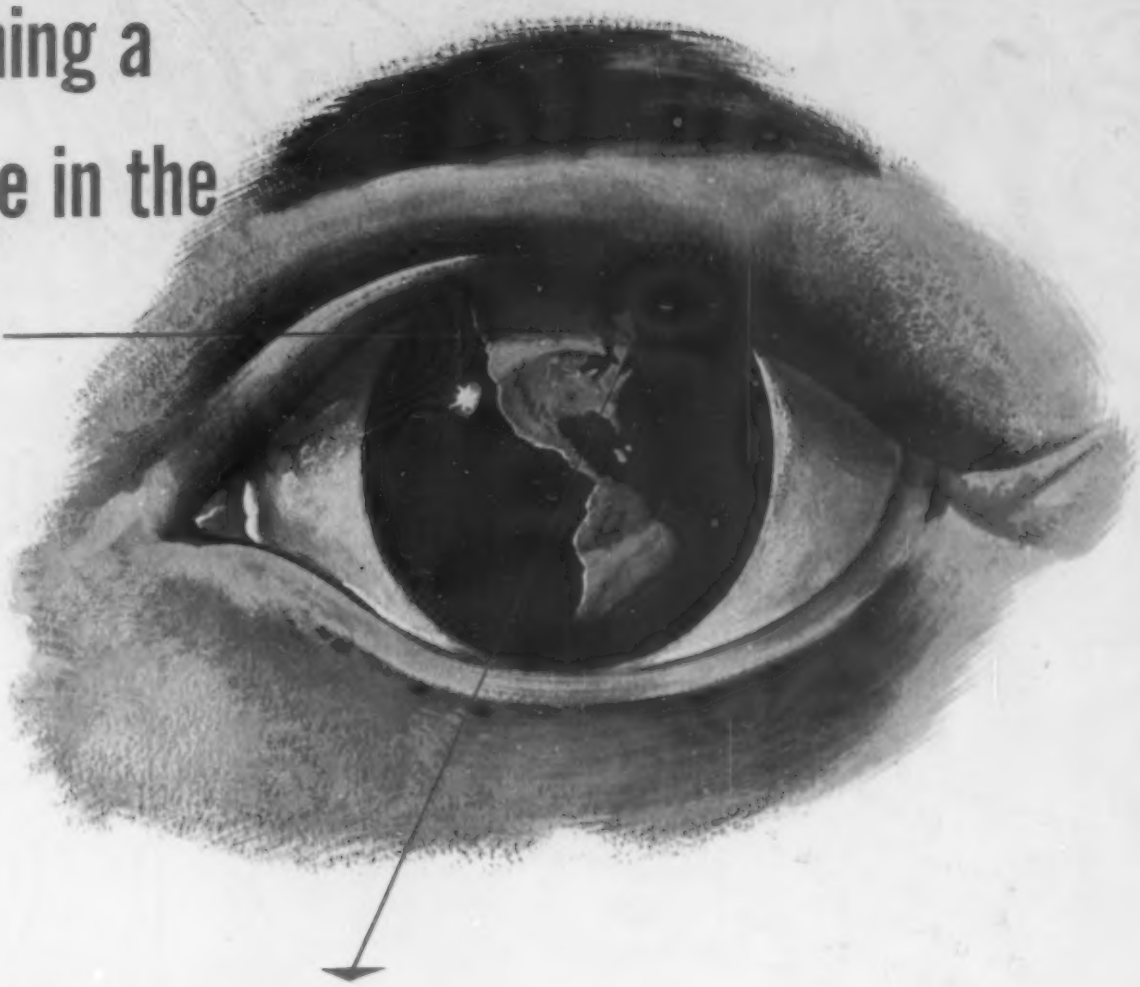
Tear Resistance • Color Fastness • Waterproofing • Resistance to
Creasing • Washability • Resistance to Stickiness under Temperature
Changes

*Send samples and specify tests required.*

**UNITED STATES TESTING COMPANY, INC.**
Established 1880
**HOBOKEN, NEW JERSEY**

PHILADELPHIA, PA. • BOSTON, MASS. • WOONSOCKET, R. I. • CHICAGO, ILL. • NEW YORK, N. Y.

# Watching a change in the times



● *"WORLD FACES PLASTIC AGE"*. . . This headline appearing recently on a feature story in a metropolitan newspaper reflects perfectly the public attitude towards plastics. To the public mind, the word "plastics" is an open sesame to a new world of wonderful new products now beyond the scope of the imagination.

We at Mills naturally are optimistic regarding the future of plastics . . . but we are realistic optimists with a firm realization of the limitations of plastics as well as an awareness of the expanding horizon of their potentialities. This combination, born of sound experience and a progressive outlook, reflects itself in the quality of our workmanship. It is also present in the analyses that we make to help determine the advisability of using plastics in the products brought to us for molding. Should your product be part of the "Plastic Age"? Let us analyze your product and answer that question for you.

Write on your letterhead for the new Injection Molded and Extruded Plastics catalogue. Or, for detailed information about MILLS PLASTIC* pipe, tubing and fittings, write for circulars, containing data and illustrations.

*Trademark Reg.

**ELMER E. MILLS CORPORATION**

Molders of Tenite, Lumarith, Plastacele, Fibestos, Lucite, Crystallite, Polystyrene, Styron, Lustron, Loalin, Vinylite, [illegible]*, Geon, Saran and Other Thermoplastic Materials

153 WEST HURON STREET • CHICAGO 10, ILLINOIS

# Deering Milliken

TEXTILES

FOR THE

PLASTICS

INDUSTRY

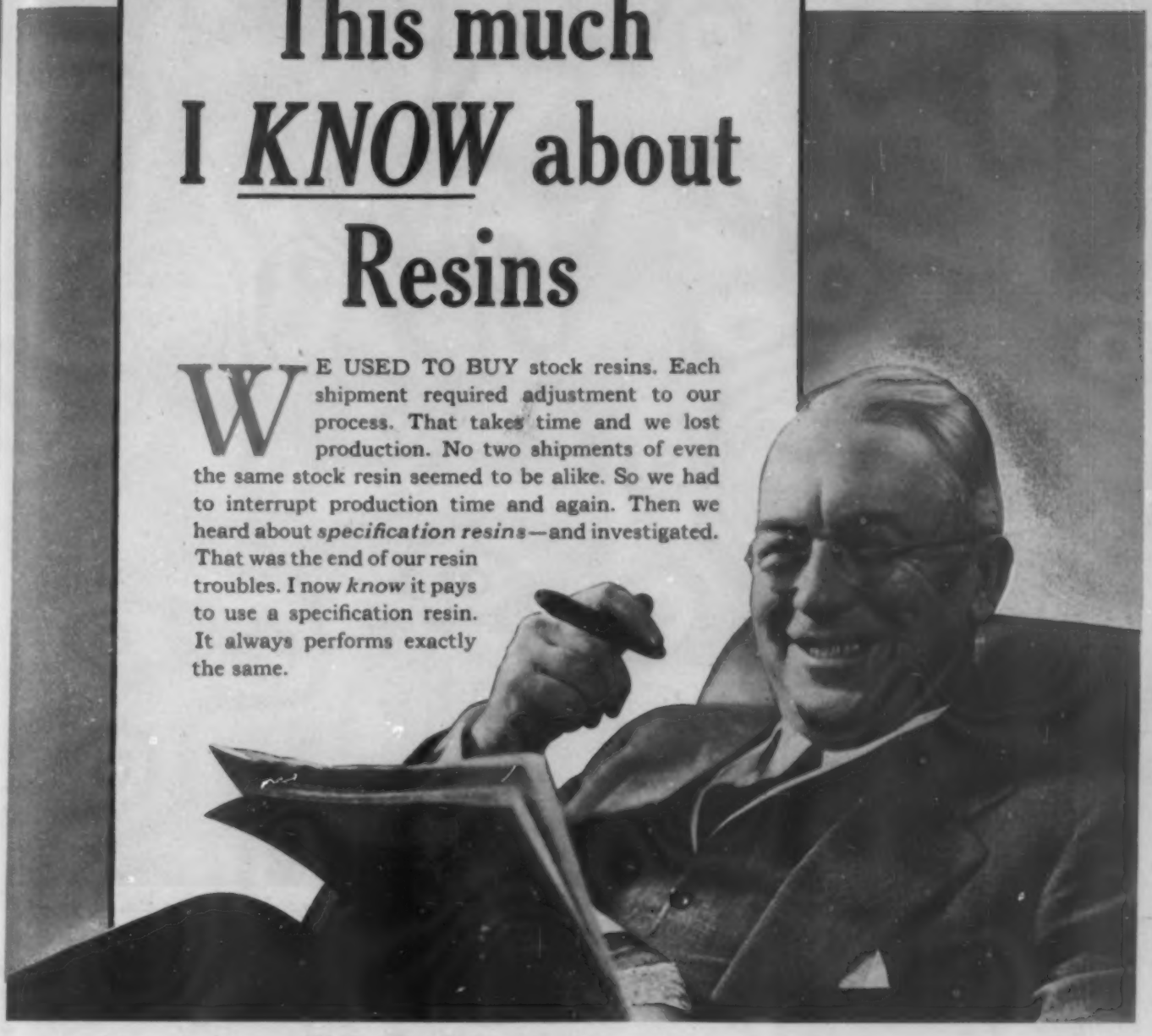
*Let our Technicians help you* *with your post-war planning*

DEERING MILLIKEN & CO.
INCORPORATED
240 CHURCH STREET, NEW YORK 13, N. Y.

Sales Offices:

| | |
|---|---|
| CHICAGO | 300 West Adams Street |
| DALLAS | 503 Texas Bank Building |
| LOS ANGELES | 111 West Seventh Street |

# This much I *KNOW* about Resins



WE USED TO BUY stock resins. Each shipment required adjustment to our process. That takes time and we lost production. No two shipments of even the same stock resin seemed to be alike. So we had to interrupt production time and again. Then we heard about *specification resins*—and investigated. That was the end of our resin troubles. I now *know* it pays to use a specification resin. It always performs exactly the same.

THE USER of Interlake resins is completely relieved of the task of fitting the resin to the job. And—the resin he gets is functionally and precisely suited *to his individual application.*

Interlake *specializes* in the development of such resins for individual applications —so stabilizing the production of each resin that the performance of every shipment delivered is identical with the first.

**IF YOU HAVE A RESIN PROBLEM,** draw freely upon the wide experience of Interlake. We will gladly work with you on any resin problem, or discuss with you the possible advantage of using resins in any operation or process. Write Interlake Chemical Corporation, Plastics Division, 1911 Union Commerce Building, Cleveland 14, Ohio.

*Interlake Production-Stabilized Resins have been developed to precise requirements of many specific applications in coating, impregnating, and bonding of . . .*

WOOD • PAPER • METAL • GLASS FIBER • RUBBER • CELLULOSE

**INTERLAKE CHEMICAL**
**Corporation**
PLASTICS DIVISION

*Specificity IN RESINS*

*85' Aircraft Rescue Boat built for U. S. Army Air Forces by Herreshoff Mfg. Co., Bristol, R. I.*

# "Captain to Engineer . . ."

# Via TULOX TT Tubing

REG. U. S. PAT. OFF.

In two-fisted PT Boats, that made life miserable (and short) for our enemies, intra-ship communications were vital. In Aircraft Rescue Boats, on their errands of mercy, they are just as vital.

In both cases, TULOX TT Tubing was chosen by Herreshoff Manufacturing Company for voice tubing.

Ever versatile, TULOX TT Tubing (extra heavy wall) was also used on PT Boats for sea-water gauge glasses.

Versatility is typical of TULOX. On land, at sea and in the air, the late war proved how well TULOX fills an amazing multiplicity of needs.

TULOX TT Tubing is *now* available for immediate delivery from warehouse stock in random 12 foot lengths, clear transparent only.

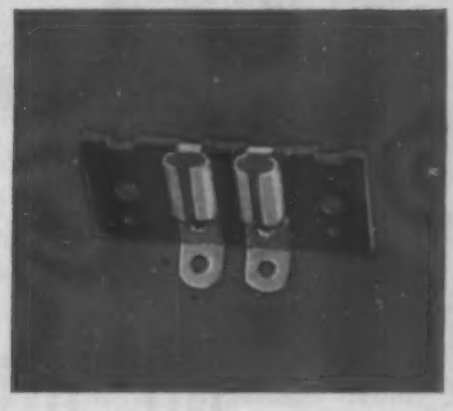
39 sizes are available in diameters from 1/8" O.D. to 2" O.D. Other sizes and colors can be made to special order only.

Send for end-use photo-folder and current data sheet.

## Extruded Plastics, Inc.

**NEW CANAAN AVENUE, NORWALK, CONNECTICUT, U.S.A.**

IN CANADA: DUPLATE CANADA, LTD., PLASTIC DIVISION, OSHAWA, ONTARIO



# Planned Perfection

The quality, utility or performance of the finished part is no better than the basic raw materials. As a master chef selects his ingredients, so we inspect mechanically, electrically or chemically all incoming material to be sure it is to the required specifications. In an electrical metal plastic assembly, for example a contact strip, the metal must be of a proper temper, size and finish and the insulating plastic be of the right grade and have the required dielectric properties so that when the parts are fabricated, assembled and shipped, you will receive a part that will do the job intended. All these extra special precautions taken by Cinch are a part of our planned perfection.

**CINCH MANUFACTURING CORPORATION**

**2335 West Van Buren Street, Chicago, Illinois**

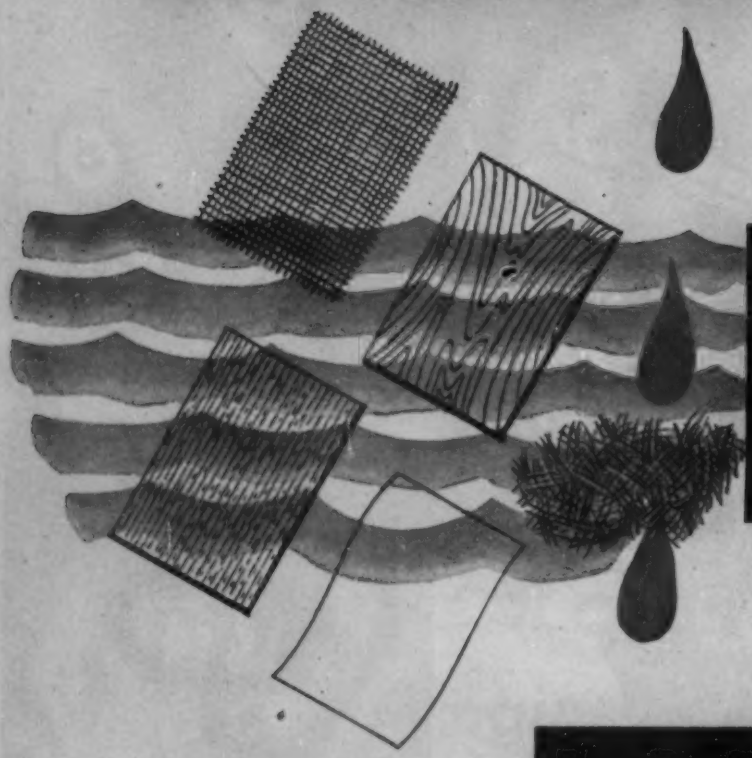
SUBSIDIARY OF UNITED-CARR FASTENER CORP., CAMBRIDGE, MASS.

*No. 5 in a Series of advertisements "MEET MEtal Plastics Engineering"*

WORLD'S LARGEST PRODUCER OF SYNTHETIC RESINS

RCI

the jack-of-all-trades . . .



. . . among liquid phenolic resins

# No. 5015 PLYOPHEN

When you need a liquid resin of high penetration with good water and chemical resistance to impregnate wood, canvas, paper, asbestos and like substances, you'll find it in No. 5015 Plyophen. This versatile resin is already being used to produce water and chemical resistant laminates, compreg and impreg . . . as a first treatment in canvas or paper to produce chemical resistance . . . as a component with lignin to produce water-resistant molding compounds and as a packing preventive on rockwool and Fiberglas. Other uses are constantly being discovered and developed. Write to the Sales Department—the chances are excellent that No. 5015 Plyophen will exactly fit one of your production problems.

Saturday Evenings at 8:30 (E.W.T.)
You Will Enjoy RCI's
"Symphony of the Americas"
Via Mutual Network Stations

## REICHHOLD CHEMICALS, INC.

General Offices and Main Plant, Detroit 20, Michigan

Other Plants: Brooklyn, New York • Elizabeth, New Jersey • South San Francisco, California • Tuscaloosa, Alabama • Liverpool, England • Sydney, Australia

SYNTHETIC RESINS • CHEMICAL COLORS • INDUSTRIAL PLASTICS • INDUSTRIAL CHEMICALS

Shuttles slamming back and forth at high rates of speed in textile looms must be able to "take" it. The *toughness* and *resiliency* of National Vulcanized Fibre provide long service.

# *National Vulcanized Fibre*

## Makes Your Products and Equipment Last Longer

**On your products—or on your plant equipment—surfaces of glass-smooth, naturally tough and resilient National Vulcanized Fibre give longer performance and more efficiency . . . at greater economy to you.**

**This remarkable property, combined with its other outstanding characteristics—its lightness in weight, its good forming qualities, its excellent machinability, its high dielectric and mechanical strength, and its extreme resistance to wear and abrasion—make National Vulcanized Fibre adaptable to a wide range of industrial applications.**

**You may see in this tough, versatile material many possibilities for your post-war projects. Write for full information now. Let one of our trained technical engineers show you how National Vulcanized Fibre can be used to advantage in your plant equipment and products.**

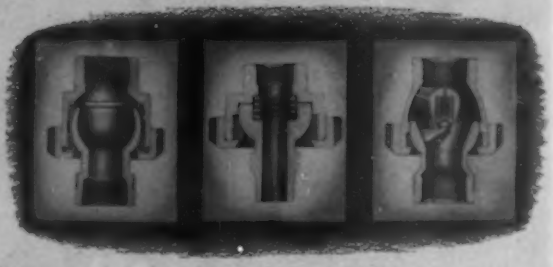
**NATIONAL VULCANIZED FIBRE CO.** WILMINGTON, DELAWARE
Offices in Principal Cities

# Nature provides flexibility in every living thing

## BARCO

provides flexibility
for the mechanical
world of movement

Flexibility is vital in any fluid-conveying system. For over 30 years, engineers in every field of industry and transportation have found that Barco Flexible Joints provide reliable protection against breaks and leakage in fluid lines. By means of responsive movement, Barco compensates for contraction and expansion, absorbs the destructive action of vibration and shock. Barco's range of design provides for every flexible joint problem. Technical Engineering Information always available. Barco Manufacturing Co., Not Inc., 1809 Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal Canada.



## BARCO FLEXIBLE JOINTS

*Not just a swivel joint...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.*

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

"MOVE IN EVERY DIRECTION"

# BAKER
## PLASTICIZERS

*are better for*

# INJECTION MOLDING

of

BUNA-S
BUNA-N
NEOPRENE
CELLULOSE RESINS
VINYL RESINS

THE BAKER CASTOR OIL COMPANY

*Established 1857*

120 Broadway, New York 5, New York

Chicago, Illinois — Los Angeles, California

Students learning mold design in a drafting class at Plastic Institute.

# MOLD DESIGN

*another important feature of practical training by*

## PLASTICS INDUSTRIES TECHNICAL INSTITUTE

THE mold design training for engineering students at Plastics Institute focuses attention on the basic principles of compression, transfer and injection molding. Problems are assigned to emphasize important mold design practices, including split cavity dies, side coring members involving the use of angle pins, automatic unthreading devices, racks and pinions. In the advanced work the engineering student prepares layouts of multiple cavity molds for various articles. Students also work upon DME mold bases, and extrusion tubing dies. The board work is accompanied by reference to the molds and machines are maintained for student practice in the molding department.

In addition to comprehensive training in mold design, every other phase of plastics is thoroughly covered at Plastics Institute. High-frequency pre-heating, low-pressure laminating, marketing and merchandising are among the newer subjects in the curriculum.

The value of *complete* instruction and training has been proved time and again by our many graduates the world over who have been successful in the plastics industry. We welcome your inquiries regarding resident training and the home study course.

**VETERANS ELIGIBLE FOR G. I. TRAINING**

A number of World War II Veterans are taking advantage of the educational provisions in the G. I. Bill of Rights to receive practical training at Plastics Industries Technical Institute. To any of your former employees returning as veterans or to any other servicemen who are interested in obtaining plastics education—we will be happy to send information explaining their privileges and details concerning our training program. Please write us.

*Plastics* INDUSTRIES TECHNICAL INSTITUTE

Francis A. Gudger, President • John Delmonte, Technical Director

WRITE DEPT. MP5-10

122 EAST 42ND ST., NEW YORK 17, N. Y. * 221 NORTH LA SALLE ST., CHICAGO 1, ILL. * 1601 SOUTH WESTERN AVE., LOS ANGELES 6, CALIF

# Drives QUICKLY... SAFELY INTO Plastics!

Also Available With Phillips Recessed Heads.

**SHAKEPROOF TYPE 25 THREAD-CUTTING SCREW CUTS ITS OWN THREAD INTO PLASTICS . . . PRODUCES STRONG, TIGHT FIT!**

● After considerable fastening research, the Make-A-Lite Division of the Chefford Master Mfg. Co., Fairfield, Illinois now fastens the metal covers of their bicycle generators to the plastic shell with Shakeproof Type 25 Thread-Cutting Screws. Because the Type 25 drives quickly and easily, cutting its own clean thread into the plastic, the assembly of the generators is fast and economical. It assures freedom from dangerous stresses or strains that are likely to cause fractures in plastic. Tapping and inserts are unnecessary. The extra wide cavity at the base of the screw allows ample space for chips produced by the cutting edge. A snug, tight fit is always certain.

This, and many other plastic applications, prove that the use of Shakeproof Type 25 Thread-Cutting Screws provide important time and money savings. Shakeproof Engineers are ready to help you incorporate this modern fastener into your product. Write today and ask for this service!

**Four Shakeproof Type 25 Thread-Cutting Screws Are Used In This Bicycle Generator**

- A knurled wheel applied against the revolving tire of the bicycle turns the generator armature, which in turn produces the electricity for the bicycle lamps.
- The four Shakeproof Type 25 Binding Head Thread-Cutting Screws hold the metal cover to the Bakelite shell. Passing through a clearance hole in the metal, the screws tap their own threads into the plastic.

*Get Free Test Kit!*

**Kit contains samples of Shakeproof Type 25 Thread-Cutting Screws in a variety of styles and sizes. Write for Test Kit No. 10 today!**

## SHAKEPROOF INC.

*fastening Headquarters*

Distributor of Shakeproof Products Manufactured by ILLINOIS TOOL WORKS
2501 North Keeler Avenue, Chicago 39, Illinois
Plants at Chicago and Elgin, Illinois
In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario
Los Angeles Office: 5670 Wilshire Blvd., Los Angeles 36, Calif.
Detroit Office: 2835 E. Grand Blvd., Detroit 2, Mich.

# *Electronics*

## ...boy wonder with a man-sized headache!

This miracle—so called—is not new; merely its maturity has been abnormally progressive under the stimulus of war. Assuredly, electronics is destined for an even greater place in every day life. Highly touted, however, the uninitiated have placed it on a pedestal tending towards absurdity.

Down-to-earth electronics *will* shine in the future. While research may never fulfill the exaggerated claims of present thinking, solutions will be provided for many persistent problems. If manufacturers and designing engineers do the job harmoniously, resourcefulness can be the antidote for over-optimism.

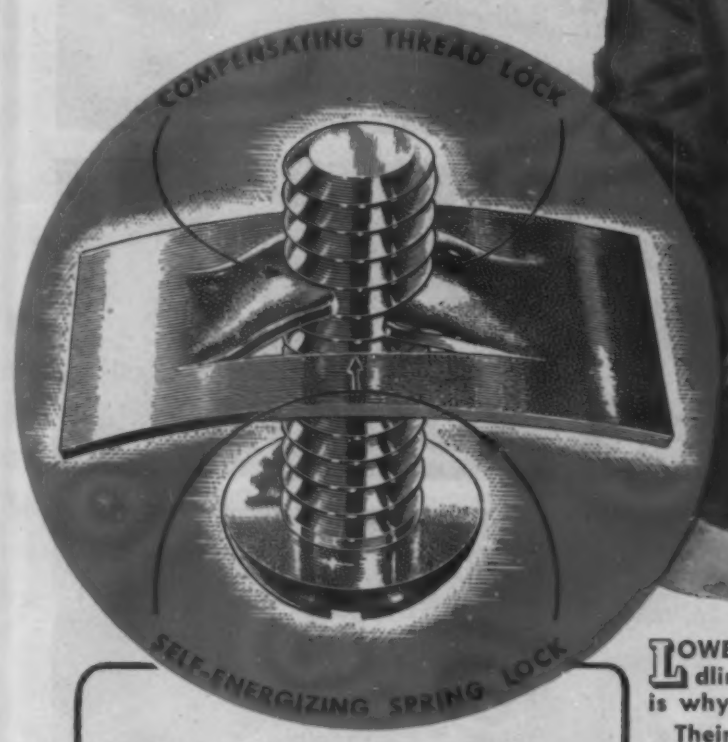
Plastic moldings can offer definite advantages in the production and functioning of electronics components. But, by the same token, they certainly do not provide "seven league boots" or "cure-all" attributes for poorly designed product conceptions.

The new MACK MOLDING 8-page brochure will help to clarify the position of plastic moldings in industry. Write for your copy today, to Mack Molding Company, Inc., 120 Main Street, Wayne, N. J.

**Mack MOLDED EXCELLENCE**

SALES OFFICES: NEW YORK CITY, CHICAGO, DETROIT, INDIANAPOLIS, BOSTON & ST. LOUIS

# WHY SPEED NUTS ARE FIRST WITH *Purchasing Agents*



**NOTHING LOCKS LIKE A SPEED NUT**

*Only SPEED NUTS provide a COMPENSATING thread lock and a SELF-ENERGIZING spring lock. As the screw is tightened the two arched prongs move inward to lock against the root of the screw thread. These free-acting prongs COMPENSATE for tolerance variations. Compression of the arch in prongs and base creates a SELF-ENERGIZING spring lock. These two forces combine to definitely prevent vibration loosening.*

**LOWER COSTS . . . reduced inventories . . . fewer handling problems . . . availability . . . in a few words, here is why Purchasing Agents prefer SPEED NUT fasteners.**

**Their initial cost, in many cases, is less than ordinary fasteners. Then, when you add in the savings in assembly time and reduction in number of parts brought about through the use of SPEED NUTS, total net assembly costs really take a tumble.**

**SPEED NUTS keep inventories down, too, because they completely do away with washers, and often eliminate many other assembly parts as well. This, of course, means quick inventory turnover and savings in the handling and dispersing of parts in stock.**

**Finally, Purchasing Agents have learned that Tinnerman service is dependable. Unlimited production and service facilities assure the utmost cooperation in getting SPEED NUTS on their way to you . . . on time. Investigation will prove that SPEED NUTS should be YOUR first choice, too. Write for information today.**

**TINNERMAN PRODUCTS, INC., 2048 Fulton Road, Cleveland 13, Ohio**

In Canada: Wallace Barnes Co., Ltd., Hamilton, Ontario
In France: Aerocasseires Simmonds, S. A., Paris
In England: Simmonds Aerocessories, Ltd., London
In Australia: Simmonds Aerocessories, Pty. Ltd., Melbourne

Speed Nuts®

PATENTED

®Trade Mark Reg. U. S. Pat. Off.

FASTEST THING IN FASTENINGS . . . OVER 3000 SHAPES AND SIZES

# PLASTIC PARTS

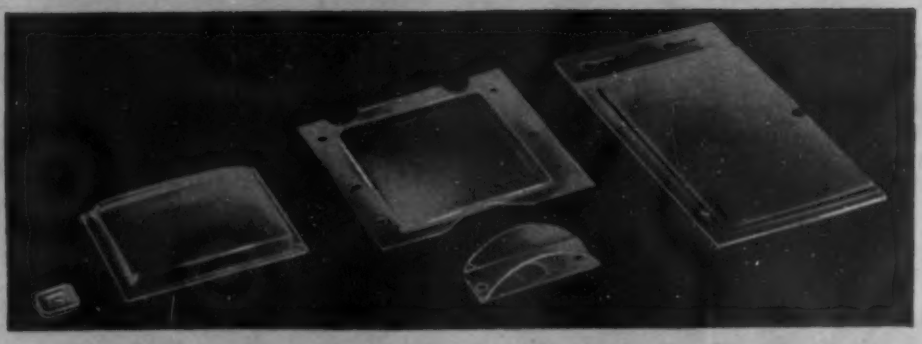
## . . . . PRODUCED TO YOUR SPECIFICATIONS

### PRINTING
### DIE CUTTING
### CEMENTING

Wide experience by all known processes in the application of printing, engraving, silk screening, die cutting and cementing of all thermoplastics.

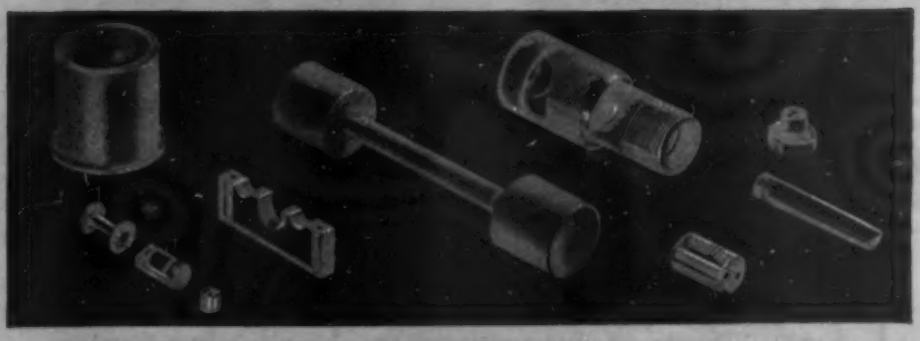
### FORMING

Specialists in deep drawing radio dial windows, embossing, swaging and bending in Acetate, Vinylite and Acrylics.



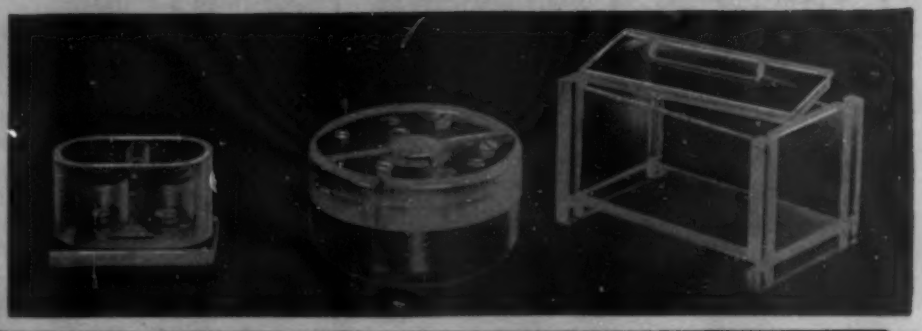
### MACHINING

Precision threading, screw machine, milling, drilling, turning of Polystyrene, Acrylics, Phenolics, Nylon, Tenite; sheets, tubes and rods; through spindle capacity up to 2½" rod.



### ASSEMBLY

Our engineers can assist you in problems of design and assembly of your plastic units.



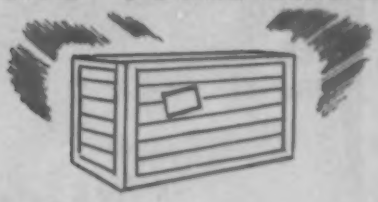
# PRINTLOID, *Inc.*

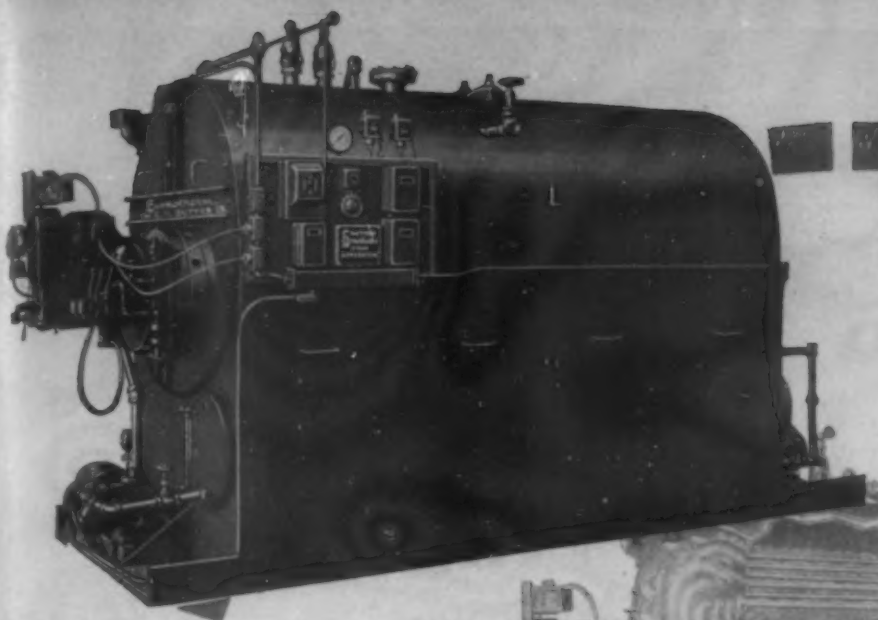
93 Mercer Street
New York 12, N. Y.

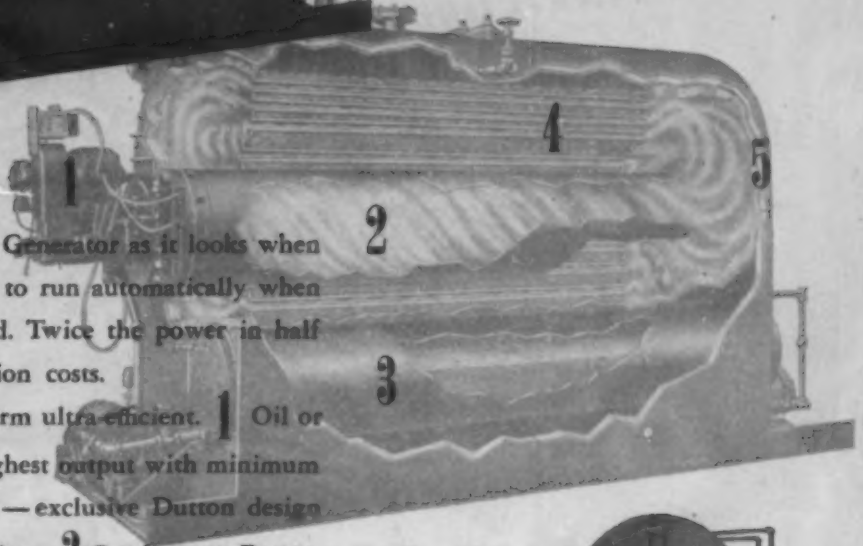
# SHIPPED TO YOU

# COMPACT

## AND COMPLETE



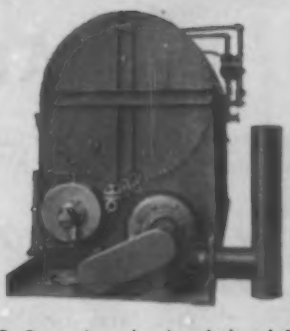





ABOVE: The Dutton Econotherm Steam Generator as it looks when uncrated — compact, complete and ready to run automatically when fuel, steam and water lines are connected. Twice the power in half the usual space — no expensive installation costs.

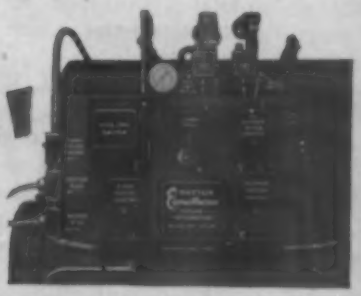
RIGHT: Features that make the Econotherm ultra-efficient. 1 Oil or gas burners with automatic ignition — highest output with minimum fuel consumption. 2 Rotary Combustion — exclusive Dutton design for increased firing and quicker steaming. 3 Condensate Return System includes tank inside casing — automatically maintains normal water level and provides makeup water as needed. 4 3 Pass Induced Draft system for faster steam, uniform circulation and good quality steam without variations in pressure or water level. 5 Boiler shell completely rock wool blanket insulated and covered with steel lagging.

WRITE FOR FULL DETAILS



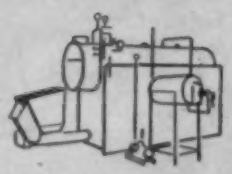
ABOVE: Rear view showing Induced Draft Fan and small vent pipe — no large, expensive stack necessary. Note streamlining and compactness.

# Dutton ECONOTHERM
## AUTOMATIC STEAM GENERATOR

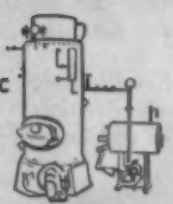


ABOVE: The Econotherm includes every instrument and control necessary for fully automatic operation. Less supervision and greater efficiency.

DUTTON ECONOMIST
HIGH PRESSURE BOILERS

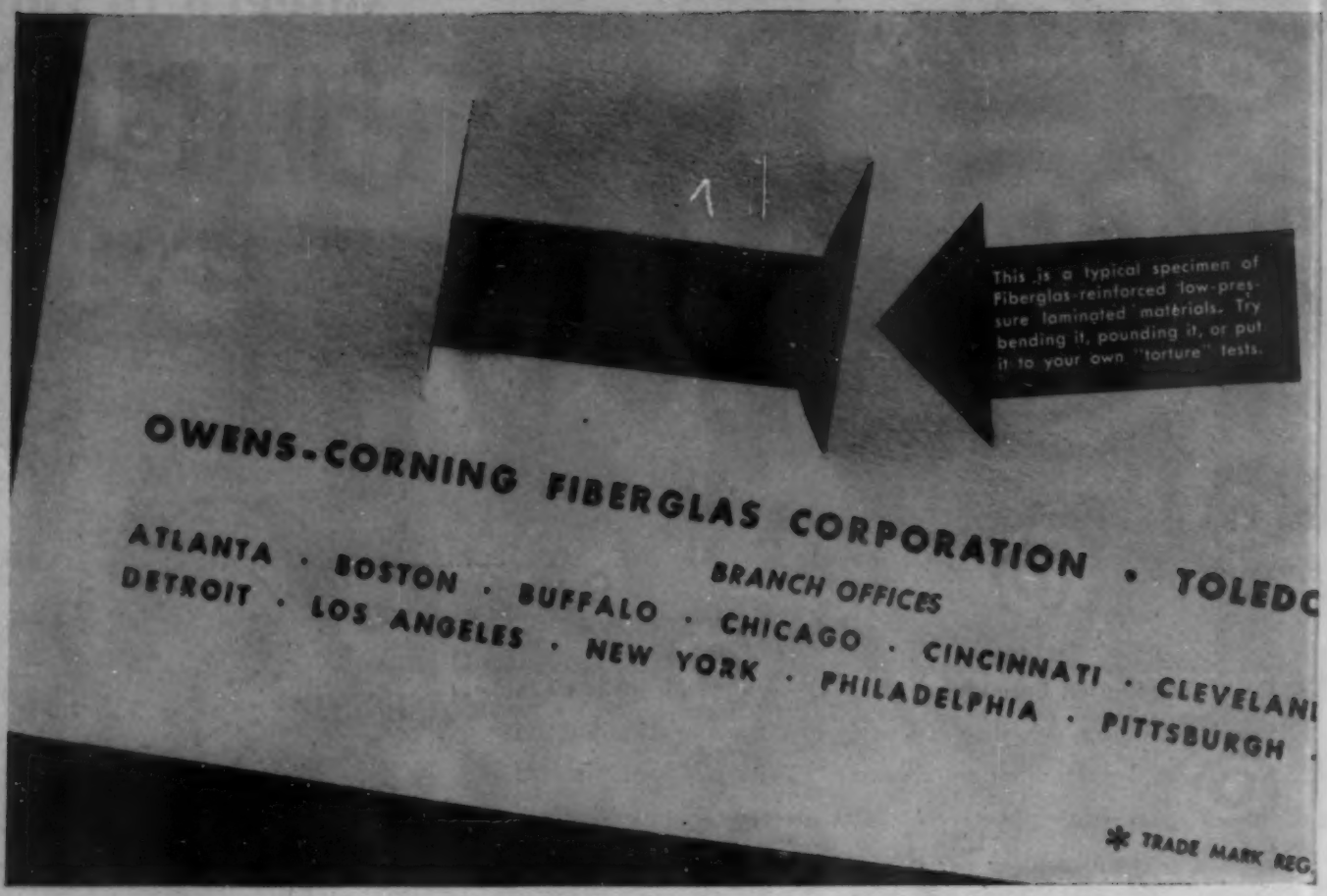


DUTTON AUTOMATIC
VERTICAL BOILERS



PRESSURE VESSELS • HEAT EXCHANGERS • CONDENSERS

**THE C. H. DUTTON COMPANY • 618 GIBSON STREET • KALAMAZOO, MICHIGAN**


This is a typical specimen of Fiberglas-reinforced low-pressure laminated materials. Try bending it, pounding it, or put it to your own "torture" tests.
OWENS-CORNING FIBERGLAS CORPORATION • TOLEDO
BRANCH OFFICES
ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND
DETROIT • LOS ANGELES • NEW YORK • PHILADELPHIA • PITTSBURGH
* TRADE MARK REG.

# WANT TO TEST IT YOURSELF?

FIBERGLAS*-REINFORCED plastics have passed the "aircraft test" with flying colors. This new material is being used in the fabrication of flat sheets, structural members and formed parts in many types of aircraft where great strength with light weight, dimensional stability, and resistance to moisture and temperature changes are of vital importance. It combines properties and characteristics which are not found in other materials.

Test it yourself. Write for the sample laminate included with the new folder "Low-Pressure Laminates Reinforced with Fiberglas Cloth". Try bending it, pounding it, or put it to your own torture test. Then determine where the advantages of this improved material can be applied to the products you are planning on making.

Fiberglas is glass in the form of fine fibers or filaments having extremely high tensile strength. Twisted into yarns, woven into cloths and tapes, these Fiberglas textiles impart their properties to the finished low-pressure plastics laminates.

For example, impact strength from five to ten times that previously obtained in laminates is now being attained through Fiberglas reinforcement. The glass fibers have great flexibility and stand high stresses without permanent deformation. They are not affected by moisture and temperature changes within the range of commercial usage; they remain dimensionally stable.

Write for your copy of the new folder, with sample attached, today. Owens-Corning Fiberglas Corporation, does not manufacture resins or finished laminates but will be glad to furnish experimental samples of Fiberglas textile materials and data on technique in their use with plastics. Write *Owens-Corning Fiberglas Corporation, 1876 Nicholas Bldg., Toledo 1, O.*

*In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*

# FIBERGLAS.. A BASIC MATERIAL

*T. M. Reg. U. S. Pat. Off.

# EXPANDED FACILITIES

## For Doing Plastic Molding Jobs EXACTLY RIGHT!

**You see above** some of the equipment for injection and compression molding in the new Amos plant—where customers get plastic molding jobs done the way they want them, *exactly right.*

**As you go through the new Amos plant** from the material and molding rooms to the die shop and finishing departments—you are impressed with all the modern equipment and all the quality controls that watch over every operation on every job. Then, when you go to the engineering department and talk with the experienced men who plan Amos jobs, you understand why customers like to do business with Amos.

**From engineering to finishing,** Amos does plastic molding jobs that go into many different fields. Whether it be a large or small component part for some machine or appliance—or an all-plastic product—Amos does the job completely—*and does it right.* Just send us your drawings or write us what you have in mind to be molded in plastics.

**AMOS MOLDED PLASTICS • EDINBURGH, INDIANA**
Division of Amos-Thompson Corporation

CUSTOM *Molders of*

*Plastic Parts and Products*

INJECTION • COMPRESSION

## DAMAGE EXPELLER!

While using slotted screws, work-spoiling driver skids were causing frequent damage to plastic shades in the assembly of desk lamps. Refinishing slowed down production, and spoilage boosted costs . . . until the manufacturer started using Phillips Recessed Head Screws.

## OUTPUT IMPELLER!

With the change to Phillips Screws, damage and delays were eliminated. And with no more worry about driver skids, power drivers could be used, speeding output further. Costs came tumbling down . . . production set new records.

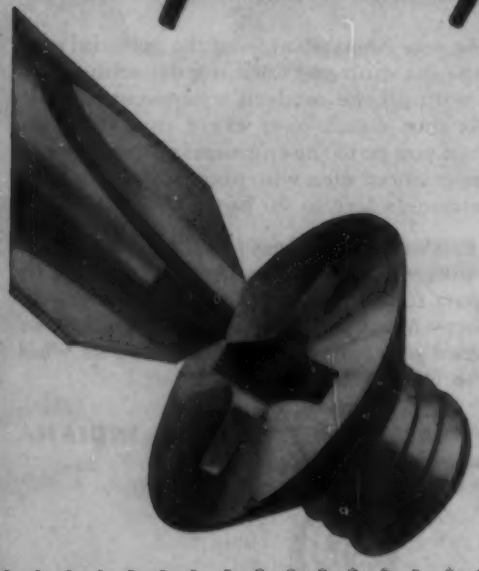
## PROBLEM DISPELLER!

Phillips Recessed Head Screws, engineered to take heavier driving pressures, simplify product design, give it more strength, more rigidity . . . often with the use of fewer screws. Screw-driving is faster, easier, surer . . . permits design innovations slotted screws just can't touch.

## SALES PROPELLER!

The Phillips Recessed Head radiates quality. It's trimmer . . . smarter looking . . . modern as tomorrow. No unsightly burrs and uneven appearance to cool off interested prospects. Put the extra sales push of Phillips Screws behind your product . . . make *good* merchandise look *better!*

# It's Phillips — the engineered recess!



In the Phillips Recess, mechanical principles are so correctly applied that every angle, plane, and dimension contributes fully to screw-driving efficiency.

. . . It's the exact pitch of the angles that eliminates driver skids.

. . . It's the engineered design of the 16 planes that makes it easy to apply full turning power – without reaming.

. . . It's the "just-right" depth of recess that enables Phillips Screw Heads to take heaviest driving pressures.

With such precise engineering, is it any wonder that Phillips Screws speed driving as much as 50% – cut costs correspondingly?

To give workers a chance to do their best, give them faster, easier-driving Phillips Recessed Head Screws. Plan Phillips Screws into your product now.

# PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS • SELF-TAPPING SCREWS • STOVE BOLTS

***Made in all sizes, types and head styles***

**25 SOURCES**

American Screw Co., Providence, R. I.
Atlantic Screw Works, Hartford, Conn.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
General Screw Mfg. Co., Chicago, Ill.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
Manufacturers Screw Products, Chicago, Ill.
Milford Rivet and Machine Co., Milford, Conn.
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
The Steel Company of Canada Ltd., Hamilton, Canada
Wolverine Bolt Co., Detroit, Mich.

# MOLDED PLASTICS

## ON-TIME DELIVERY WILL HELP YOU WIN THE RACE TO MARKET

The race is on... with rich rewards posted for the manufacturers who get to market first with new models.

Do molded plastic parts figure in your plans? If so, are your designs completed? Have your molds been made? Is actual production scheduled to your satisfaction? We will pick up your molded plastics problem anywhere along the line... and help you eliminate needless delays.

Consulting in advance with our design-engineers may save you much lost motion. You will waste no time waiting for completion of molds... we make our own molds in our own fully equipped tool room. The most advanced molding and finishing equipment... sparked by production "know-how"... safeguards the quality and assures on-time delivery of your molded plastic parts. Submit your product or problem... *now*... to MOLDED PRODUCTS CORPORATION, 4533 W. Harrison St, Chicago 24, Ill.

PLASTICS DIVISION

**MOLDED PRODUCTS**

CORPORATION

*However unusual the pattern, however rare the colors, you can depend on* PLEXON *to create a gorgeous fabric for you!*

Lends Wings to the imagination

PLEXON weaves rapidly, successfully, and without slipping, on all types of looms...no changeover is necessary. The colors are permanently imbedded, the yarn brilliant or mat, to your order.

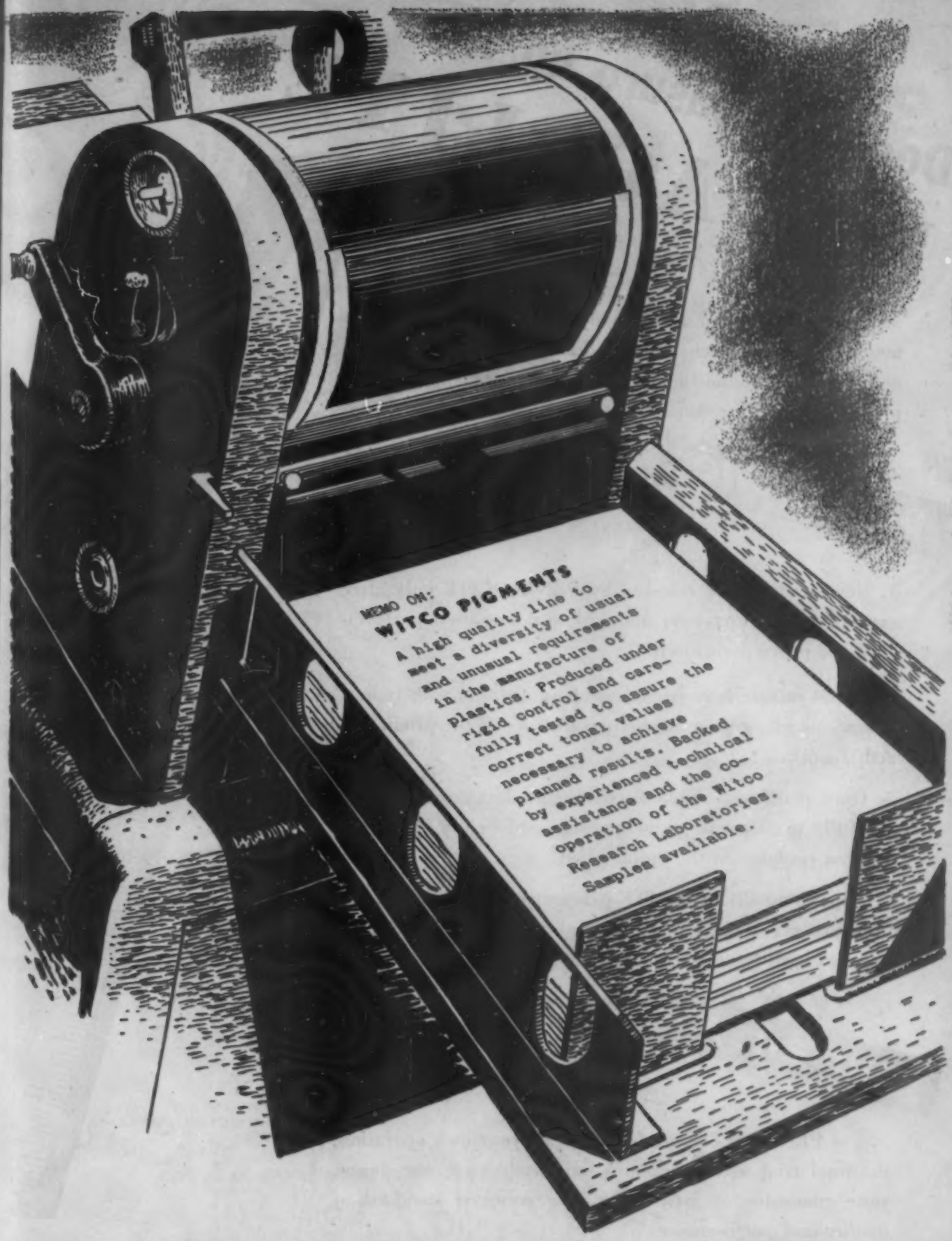
PLEXON

THE PLASTIC COATED YARN

REG. U.S. PAT. OFF.

Truly, PLEXON lends wings to the imagination!

Freydberg Bros. Strauss, Plastics Division, New York, N. Y.


MEMO ON:
WITCO PIGMENTS
A high quality line to meet a diversity of usual and unusual requirements in the manufacture of plastics. Produced under rigid control and carefully tested to assure the correct tonal values necessary to achieve planned results. Backed by experienced technical assistance and the cooperation of the Witco Research Laboratories. Samples available.

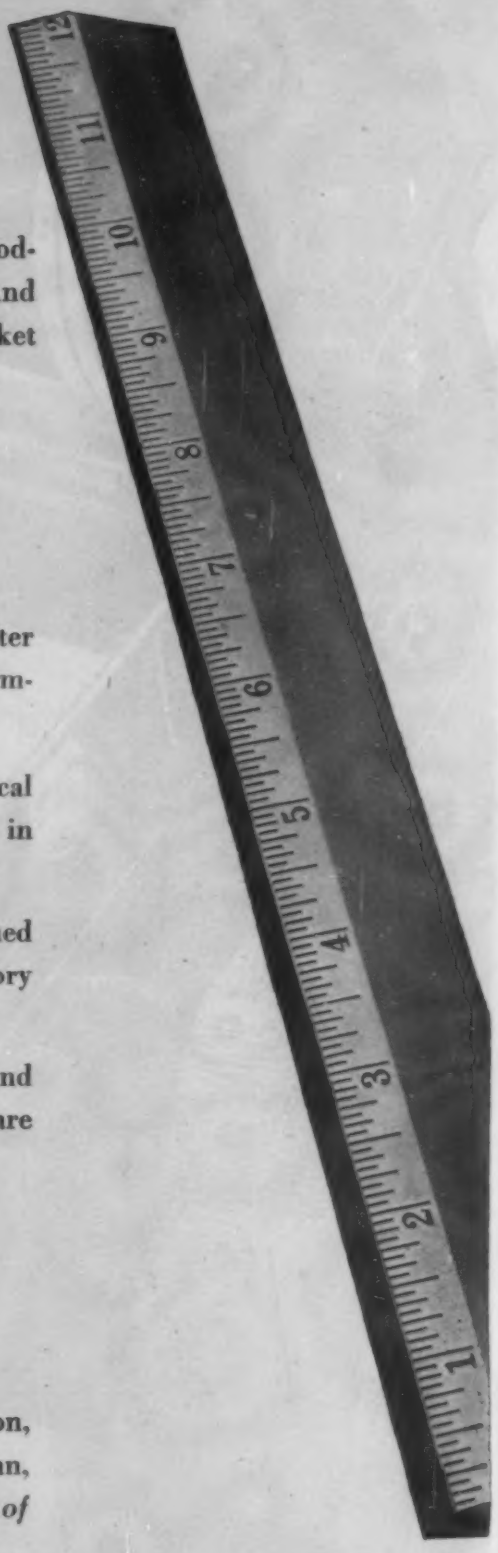
# WITCO CHEMICAL COMPANY

MANUFACTURERS AND EXPORTERS

**[Formerly Wishnick-Tumpeer, Inc.]**

295 MADISON AVENUE, NEW YORK 17, N. Y. • Boston • Chicago • Detroit • Cleveland • Akron • London

# Does it measure up to PENACOLITE?



. . . is a question pondered daily by Pennsylvania Coal Products Company research, sales, and management forces. And not simply in connection with new developments. Market proved products are its subject too.

## our answer

1. New products are released by PENACOLITE only after extensive laboratory tests designed to define their performance and prove their merit.

2. Initial release is restricted to manufacturers with typical operations who report on the performance of the product in actual work.

3. Once qualified for general sale, the product is still watched carefully to detect wrinkles undiscovered in the laboratory and not revealed in the "pilot plant" stage.

4. Reports on PENACOLITE performance are solicited and problems revealed by unanticipated uses and conditions are referred back to research for solution.

## your answer

. . . is PENACOLITE performance in your own operation, the final trial which measures our products to our slogan, your guarantee of satisfaction, *the accepted standard of quality and performance.*

**PENNSYLVANIA COAL PRODUCTS COMPANY**

PETROLIA, PENNSYLVANIA

# *Exclusive*

This automatic pistol, injection molded by Pyro, looks like the real thing.

These plastic coat hooks are injection molded in one piece in attractive colors.

The reputations of many leading furriers are based not on the size of their organization but on their exceptionally high quality of workmanship.

Here at Pyro we are ideally set up to service a small group of customers. We have a compact organization of experienced engineers and expert craftsmen skilled in producing high quality injection moldings. Your inquiries will receive the personal attention of one of our executives.

*For fine workmanship specify* **Pyro** *molded plastics*

**THE PYRO PLASTICS COMPANY · WESTFIELD · NEW JERSEY**

# PRECISION

Another good example of the kind of *precision* work we will be doing after the war, is the *frame* on this attractive, popular priced hand bag. Before coming to us the manufacturer used a fabricated frame. *We mold it all in one piece*, and the result is a worthwhile saving in time, labor and money. If you examined the frame closely you'd see that it combines both heavy and light sections which is always a challenge to the molder's skill.

Right now, of course, most of our production is for war but some of these days the much discussed *postwar* period will be actually here—*and then* you'll want to remember the name PRECISION.

PPC

**PRECISION** *Plastics Company*

4647-61 STENTON AVE. PHILADELPHIA 44, PA.

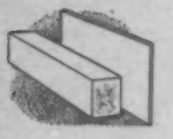
# Low Speeds FOR METAL!

# High Speeds FOR WOOD!

## YOU GET BOTH IN

# Walker-Turner

## 14-16 INCH BAND SAWS



Walker-Turner 14" and 16" Band Saws are equipped with back-gearing and cone pulley. This enables the operator to select correct low speeds for metal-working. By simply throwing a lever and engaging a pin, the gear train is disconnected and the Band Saw converted into a direct drive machine—with higher speeds for non-ferrous metals, plastics and wood.

Walker-Turner Band Saws have a speed range from 61 to 5300 s.f.m. Blade tensioning devices have spring cushions to absorb shocks. Heavily-ribbed, carefully-machined tables tilt to 45°. Send today for latest catalog.

**PRICE**
(with gear unit)
**$127.50**
(less base and motor)
F.O.B. Plainfield
(slightly higher west of Rockies and Canada)

**WALKER-TURNER COMPANY, Inc., PLAINFIELD, NEW JERSEY**

walker-Turner COMPANY, Inc. PLAINFIELD, N.J. U.S.A.

# MACHINE TOOLS

DRILL PRESSES — HAND AND POWER FEED • RADIAL DRILLS
METAL-CUTTING BAND SAWS • POLISHING LATHES • FLEXIBLE SHAFT MACHINES
RADIAL CUT-OFF MACHINES FOR METAL • MOTORS • BELT & DISC SURFACERS

*NOW* that our war assignment is completed, we are ready to furnish peace time products through our enlarged and improved facilities.

As a long-time leader in molded plastic trim for stoves and other appliances, Grigoleit may be relied on to provide the best in product design and manufacture. Here, you'll find the last word in either plastics or plastics and metal trim. Or you may select your handles, knobs, and parts from an extensive stock line appropriate for many appliances or furniture products.

Also included in Grigoleit products is a line of stock molded plastic closures for many purposes—and a complete service for custom molding of thermoplastic and thermo-setting plastics.

**THE GRIGOLEIT COMPANY, Decatur 80, Illinois**

PULP AND PAPERS, CUSTOM-MANUFACTURED FOR PLASTICS APPLICATIONS

DECORATIVE LAMINATES . . .

Precision-Made Resin Impregnating and Coating Base Stocks with UNIFORM Density Formation Caliper

Though specifications tend to vary to meet the individual need, most of our decorative impregnating papers have the following characteristics:

(1) Uniform Cleanliness
(2) Non-fading Brightness
(3) Clear, Even Formation
(4) Sufficient strength in aqueous solvents to allow maximum production

Requests for sample runs of printed impregnating paper have been received. The Munising Paper Company does no printing itself but is in a position to supply web printing with continuous designs in light-fast and aqueous-fast inks. We welcome the opportunity of submitting either plain or printed rolls for impregnating purposes. If special designs are wished, sketches will be supplied without charge.

*The Munising Paper Company*

Sales and Executive Offices • 135 South La Salle Street, Chicago 3, Illinois • Pulp and Paper Mills at Munising, Michigan

MUNISING PAPER

◆ MANUFACTURERS OF PRECISION MADE PULP AND PAPERS FOR MORE THAN 40 YEARS

# For products never before shipped in bulk...

# We design tank cars never built before

**Sulphuric acid, chlorine, helium** and many other hard-to-handle liquids and gases were made more useful to American industry, when General American designed specialized tank cars to carry them. Special problems of pressure control, contamination, and corrosion have been met by General American research engineers.

***Your future operations*** may require liquids never shipped in bulk before. Call on General American for tank cars—built specifically for those products. You will get safe, sure transportation that cuts costs for your competitive advantage.

GATX GENERAL AMERICAN

**GENERAL AMERICAN TRANSPORTATION**

CORPORATION

CHICAGO

Builders and Operators of Specialized Railroad Freight Cars

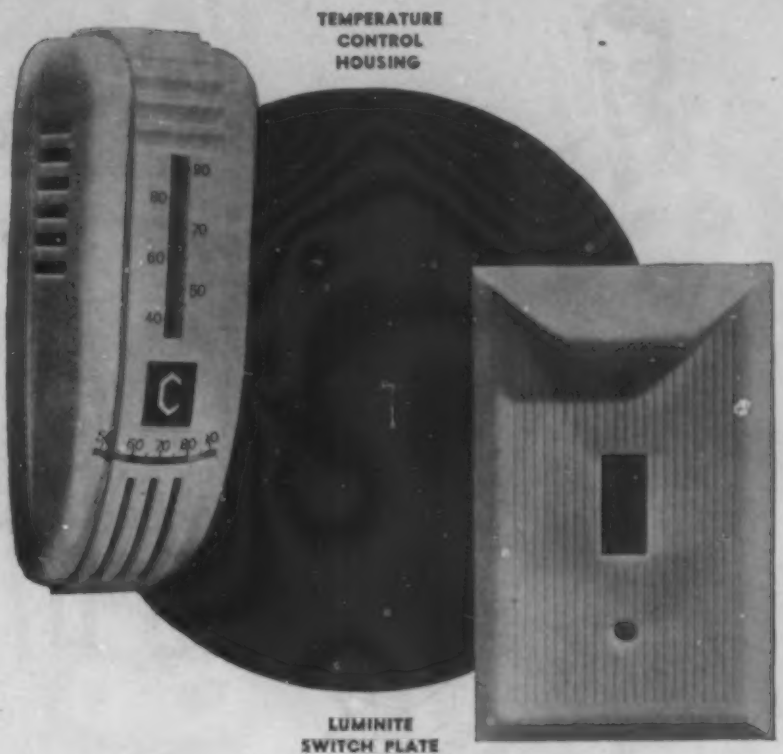
Bulk Liquid Storage Terminals

Process Equipment of All Kinds

Pressure Vessels and Other Welded Equipment

Aerocoach Motor Coaches

Processing Service for Fruits and Vegetables




# *Yardley Also Does*
# INJECTION MOLDING

**You are right in thinking that Yardley has exceptional know-how when it comes to all kinds of extruded plastics. But many modern molded items are Yardley-made, too.**

**Present facilities include equipment for turning out molded castings up to 12 ounces in weight. Consult us.**

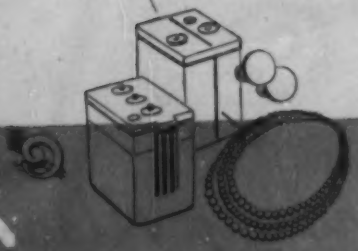
## YARDLEY *Plastics Co.*

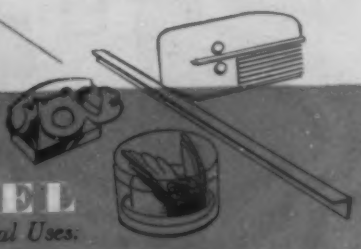
142 PARSONS AVE. COLUMBUS 15, OHIO

Extruders of SARAN, CELLULOSE ACETATE, BUTYRATE, POLYSTYRENE, STYRALLOY and VINYLS. Also Injection and Compression Molding.

# reading from left to Right in Plastics

# DOW





## STYRON

*Present and Potential Uses:*

Lighting fixtures; insulators; battery cases; hydrometers; funnels; closures, food handling equipment; pharmaceutical, cosmetic and jewelry containers; costume jewelry; novelties, refrigeration parts; pens; pencils; liquor dispensers; escutcheons; chemical apparatus; lenses; decorative objects, trim.

*Properties:*

Clear, translucent or opaque; broad color range; excellent high frequency electrical insulator; can "pipe" light through rod at angles, and around corners; resistant to acids and many alkalies; low water absorption; light weight; stable at low temperatures.

## ETHOCEL

*Present and Potential Uses.*

Housings; radio cabinets; aircraft parts; containers; insulators; flashlights; automotive parts; escutcheons; refrigerator parts; tool handles; rods, tubes, bars, and special extruded shapes for kitchen trim; automotive and aircraft window frames; modern window blinds. Also used as tape and wire coating.

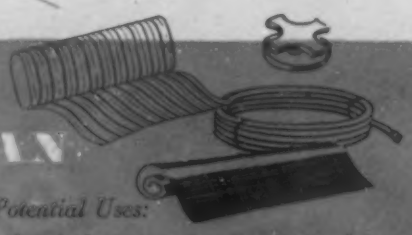
*Properties:*

Extra tough, particularly at low temperatures; attractive colors; pleasant to handle; transparent or translucent; dimensionally stable to varying climatic conditions and temperatures; light in weight; available in wide range of flow; not available in crystal color; limited chemical and solvent resistance.

We at Dow know from experience that success in plastics is not a one-man nor even a one-industry job. It calls for the combined skill and cooperation of manufacturer or designer plus fabricator plus raw materials producer. Working together, this team saves time and money and puts plastics to work successfully. Call us—we'll do our part.

Putting plastics in the right place is your business. It is our business to *produce* the right plastics and, whenever possible, aid in their application. That's why we present this quick guide to Dow plastics. You are probably already familiar with it. Most designers are. Perhaps it will help you to find the material you're looking for right now.

# PLASTICS



## SARAN

*Present and Potential Uses:*

Plating masks; chemical apparatus; pump parts; valves and valve parts; name plates; meter parts; paint brush handles; insulation; funnels; bottles; closures; plumbing equipment; wire coating, etc.; pipe and tubing for installations requiring chemical and corrosion resistance; monofilament for textiles.

*Properties:*

Resistant to chemicals, abrasion, corrosion, water and moisture; good electrical insulator; excellent thermal insulator; non-flammable; tough; flexible; dimensionally stable; not recommended for installations requiring temperature resistance above 170° Fahrenheit.

## STYRALOY 22

—new Dow-developed synthetic elastomer now commercially available. Produced originally for special electrical applications, its many unique qualities point to a much broader range of uses.

*Present and Potential Uses:*

One-piece cable sheathing; handles for tools; household appliances, etc.; gaskets; bushings; coil forms; floor mats; many applications still to be ascertained.

*Properties:*

High dielectric strength, low power loss over all frequencies. Power factor only .005 at 100-300 megacycles. Flexible and shock resistant from —90° F. to 212° F. Specific gravity less than 1. Water absorption only 0.2 to 0.5%. Resists heat, ozone, most chemicals, abrasion, permanent indentation. Ideally suited to extrusion of complex cross sections and readily fabricated by other techniques. Easily machined.

THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit
Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

DOW
PLASTICS
STYRON • ETHOCEL • ETHOCEL SHEETING
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MT. VERNON EXTRA

ASSOCIATED WITH UNIFORM QUALITY FOR OVER HALF A CENTURY

**The Fabric Backbone that Makes Uniform Laminates**

Because it takes a uniformly woven fabric to make a uniform fabric laminate, MT. VERNON Extra laminate duck is constantly checked, corrected, and controlled in manufacture by an array of laboratory equipment as modern as plastics itself. The resulting weave reinforces the strength, toughness, resiliency, flexibility and absorptive properties of this top-grade cotton duck—provides a known quantity that you can depend on consistently, when you specify MT. VERNON Extra.

MT. VERNON WOODBERRY MILLS, INC.

**TURNER HALSEY COMPANY**

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# All there is in bearings

The Timken Roller Bearing Company has pioneered in the development of tapered roller bearings for 47 years with an unapproached record of engineering achievement.

The Timken Company is the only bearing manufacturer in the country which makes its own steel. This gives us positive control of all materials before fabrication.

Timken Bearings are serviced wherever transportation or mechanical equipment is used throughout both hemispheres.

No other bearing has these exclusive advantages as well as innumerable other refinements of equal importance.

You will do well to make it an invariable practice to specify Timken Bearings throughout your plant or product. The trade-mark "TIMKEN" is stamped on every genuine Timken Bearing. Look for it on every bearing you use. The Timken Roller Bearing Company, Canton 6, Ohio.

*Timken Bearings, Timken Alloy Steels and Tubing and Timken Removable Rock Bits*

TIMKEN
TAPERED ROLLER BEARINGS

**"All There is in Bearings"**

COPYRIGHT 1945 THE TIMKEN ROLLER BEARING CO.

# IF YOU NEED PLASTICIZERS FOR

VINYL COPOLYMERS

POLYVINYL CHLORIDE

POLYVINYL BUTYRAL

NITRO-CELLULOSE

CELLULOSE ACETOBUTYRATE

ACRYLIC RESINS and

SYNTHETIC RUBBERS

## HARDESTY CHEMICAL CO. CAN SERVE YOU

HARCHEM

**PLASTICIZERS**

Alkyl Roleates

Dibutyl Sebacate

Capryl Alcohol

HARDESTY CHEMICAL CO., INC., 41 EAST FORTY-SECOND STREET, NEW YORK 17, N. Y.

Such *strength* in a *lightweight!* A rare combination on gridirons—or in materials. But it's yours in KYS-ITE . . . in addition to other properties no other type of material combines.

Putting KYS-ITE into your plans means putting yourself ahead in postwar competition—so why not be familiar with the features listed here?

### GREAT STRENGTH WITH LIGHT WEIGHT

Preformed before curing, an even distribution of phenolic resin on interlocking fibres results in great tensile and compressive strength and with an impact strength up to 5 times that of ordinary plastics.

### WIDE RANGE OF SHAPES

Complicated pieces with projections and depressions, large or small shapes and sections—all these and more, too, are molded successfully in KYS-ITE.

### KYS-ITE CAN "TAKE IT"

Unusually durable and resistant to abrasion, impervious to mild alkali and acid solutions.

### INTEGRAL COLOR

KYS-ITE's lustrous finish is highly durable; the color is an integral part of the material itself. A wipe and it's bright!

### NON-CONDUCTOR

KYS-ITE's dielectric properties make it invaluable where safety is a factor. Also a non-conductor of heat. Non-resonant and non-reverberating.

### WE WANT TO HELP YOU, BUT

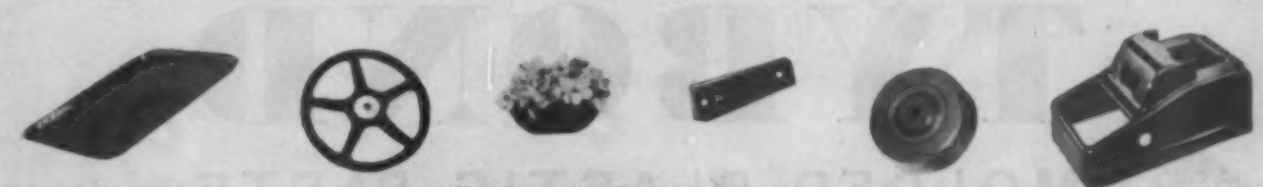
Heavy demand for KYS-ITE is keeping our men and machinery so busy that scheduling of further orders is indefinite at this time. When the lifting of present restrictions helps relieve this situation, you can be sure we'll let you know.

***Buy Victory Bonds—and Keep Them***

KEYES FIBRE COMPANY
420 Lexington Avenue
New York 17, New York
Plant at Waterville, Maine

**KEYES**
MOLDED PRODUCTS

**KYS-ITE articles indicating the range of items we mold to specifications and deliver complete, ready for use.**



# KYS-ITE*

**Preformed Plastic Combining Long-Fibered Wood Pulp and Synthetic Resin**

*Trademark Reg. U. S. Pat. Off.

# *When your product*

## is at the design stage

Many buyers of compression molded plastic parts have found it helpful to call in TYBOND when the product is at the design stage.

We have made scores of suggestions that have resulted in reduced weight, enhanced physical properties, closer tolerences and, frequently, substantial reductions in die costs.

TYBOND offers qualified chemical, metallurgical, electrical engineering and designing counsel—implemented by eminently successful execution of difficult plastic assignments for the armed forces.

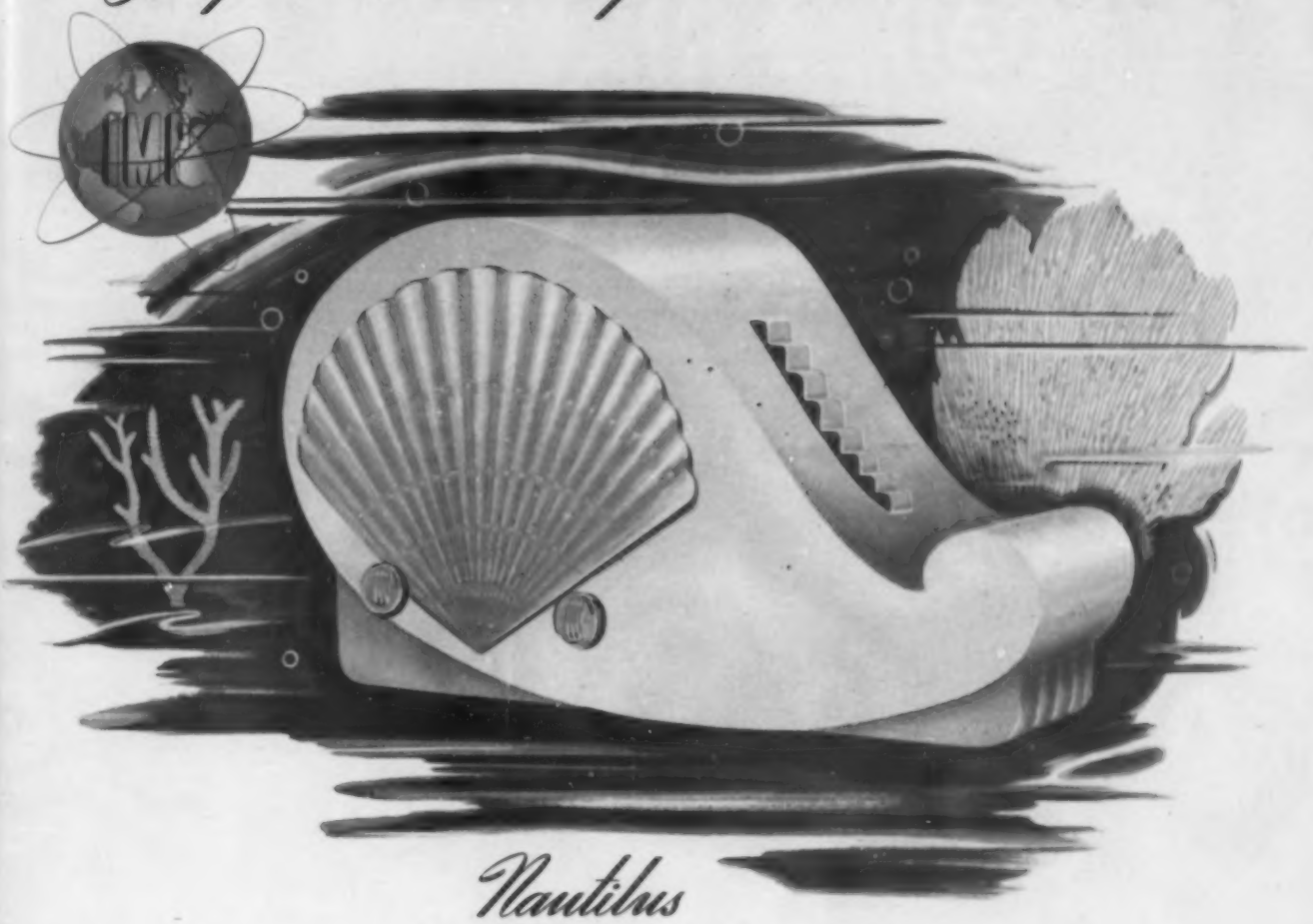
Complete TYBOND services range from design engineering to delivery of the finished product—as much or as little as you require. We are small enough to give you personalized service, large enough to produce in the millions. Send us your prints for quotation, or tell us your problem. There is no obligation.

# TYBOND

## MOLDED PLASTIC PARTS

TYBOND PRODUCTS CO. 2435 N. WESTERN AVE., CHICAGO

# *Compression Molding Tunes-in on Tomorrow...*



*Nautilus*

**The imaginations of today become the realities of tomorrow. ☆ We invite those who think ahead to think of *International Molded Plastics, Inc.* for quality molding of modern design.**

☆

**INTERNATIONAL MOLDED PLASTICS, INC.** ☆ ☆ ☆

☆

4387 WEST 35th STREET · CLEVELAND 9, OHIO

# Mold Automatically

## A STOKES PRESS FOR EVERY NEED

Completely Automatic Molding — on Stokes Presses — is the acknowledged, *most economical* method for producing thousands of different plastics parts.

Automatic Molding saves molding labor . . . one man operates a battery of presses. It saves time and material . . . cycles are greatly reduced through split-second timing and flash losses reduced 8% to 10% or more.

Mold cost is low because a few cavities are used to do the work of many. Product changes can be made quickly and economically because molds can be made in a fraction of the usual time and at minimum cost.

Output is high . . . up to 10,000 or more moldings per week per cavity. Parts are produced as needed, reducing excessive inventories. Parts are of highest quality . . . there are no human errors to contend with.

For your present or post-war parts, consider the advantages of Automatic Molding with Stokes Presses. Write for full information now.

**F. J. STOKES MACHINE CO.** 5934 Tabor Rd. Phila. 20, Pa.

**STOKES 15-TON COMPLETELY AUTOMATIC MOLDING MACHINE** — the machine that established Automatic Molding as sound, economical practice. Hundreds are in service making thousands of different molded pieces. Complete, self-contained unit, electrically powered and heated.

**STOKES 50-TON HYDRAULIC COMPLETELY AUTOMATIC MOLDING MACHINE** for larger pieces and more pieces. Features same patented controls as the 15-ton press—Automatic Cycle Controller, and Super-Sensitive Trap that checks every piece made and literally "runs the press" . . . the only proved and foolproof method of operating a Completely Automatic machine. Only 2 hp. motor required to develop full 50 tons press capacity. High-speed operation with controlled closing speed.

*50th year of Service to Industry*

**F.J.Stokes** MOLDING EQUIPMENT FJS EST 1895

# National Lock Co. Increases Output 20 to 50% With RCA Electronic Heat

## Complex Bomb and Fuse Parts Improved by Fast, Uniform Preheating; Costs Cut

MOLDING operations on the two parts shown at the right were greatly improved by National Lock Company, Rockford, Illinois, by the application of electronic preheating.

**BOMB NOSE:** The 64-gram bomb nose, transfer-molded in a 4-cavity mold from Monsanto type 4315 impact material, was difficult to produce with steam-table preheating because dimensions could not be held successfully.

With electronic preheating, four 64-gram preforms are brought to 250°F in 20 seconds. With steam, preheat temperature could be brought to only 160°F. Press closing time dropped from 45 to 15 seconds; curing time in the mold from 3¼ to only 2 minutes. *Production was increased 50% by electronic heat; dimensional tolerances were successfully held.*

National Lock Company was among the first to install RCA Model 2B electronic units—specially designed for plastics preheating—which have set design standards for the industry.

**BOMB-BOOSTER CASING:** Six bomb-booster casings per mold are compression-molded by National Lock from Makolot type 1155 general-purpose material using wood-flour filler. Two 58-gram preforms are required for each cavity.

Formerly, electric-oven preheating was used. Preheat temperature was 175°F; preheat time, 30 minutes. With electronic heat, preheat temperature is 220°F; preheat time is 40 seconds with an RCA 2000-watt unit, or 20 seconds with the larger RCA 15,000-watt unit. Curing time in the mold is reduced from 1¾ to 1¼ minutes. *Overall press output was increased 20% and considerable material was saved that had been improperly heated by the oven method.*

Information on these applications of electronic heat was supplied by Mr. Frank Spoden, Foreman of the National Lock Company's Plastics Department.

**YOUR APPLICATION PROBLEMS** for electronic heat will be carefully studied by RCA engineers. For long life, high output, and economy, use the famous RCA Model 2B. Address your request for free bulletin to: Radio Corporation of America, Electronic Apparatus Section, Box 70-198, Camden, N. J.

**Press output was increased 20%** when National Lock Co. installed the RCA electronic preheating unit shown above. This automatic 2000-watt unit preheats material for 4 presses in rotation. Each press charge weighs 696 grams, and is heated to 220°F in just 40 seconds. Finished piece is shown below, at left.

**National Lock Co.** also uses an RCA 15,000-watt electronic heater for this bomb-booster casing job. The safety-cage above, built by National Lock engineers, is conveniently located near presses; generator is in nearby room. Preheat time for 696-gram charge is 20 seconds.

**Production on this bomb** nose (at left, above) was stepped up 50% by the use of electronic preheating. The RCA Model 2B electronic unit (in background—lower photo) preheats a 256-gram load to 250°F in 20 seconds, and supplies two presses continuously.

RCA ELECTRONIC HEAT

BUY VICTORY BONDS

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION, CAMDEN, N. J.

# DISSTON PLASTIRON

## TWO FINE STEELS THAT ASSURE PERFECT PLASTICS MOLDS

# DISSTON PLASTALLOY

If your mold requirements call for easy hobbing and clean, sharp definition, you will find one or both of these highly specialized Disston Steels ideally suited. Each is produced in electric furnaces from carefully selected raw materials by modern steel practice and under careful control.

DISSTON PLASTIRON is recommended for intricate shapes and short runs. It withstands extreme hobbing, carburizes evenly, and produces smooth, clean cavities without soft spots.

DISSTON PLASTALLOY is recommended for molds that will be subjected to longer runs. It is a low carbon steel containing nickel and chrome, and so alloyed as to produce the greatest core strength and resistance to wear and abrasion consistent with easy hobbing. Each possesses these important advantages:

- A low carbon content.
- Thoroughly clean and uniformly sound.
- Produces unusually smooth cavities.
- Will withstand extreme hobbing.
- Carburizes evenly.
- Ideal for difficult shapes.

**DISSTON ENGINEERS WILL BE GLAD TO HELP YOU IN YOUR PLANNING**

A long and close association with the plastics industry has given Disston engineers and metallurgists valuable experience which may prove helpful to you. The lessons learned from this experience are available to you. You may feel free to submit your problems, knowing that you will be advised frankly, in confidence and without obligation.

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*Small plastic pieces automatically Metaplated in large volume at low cost.*

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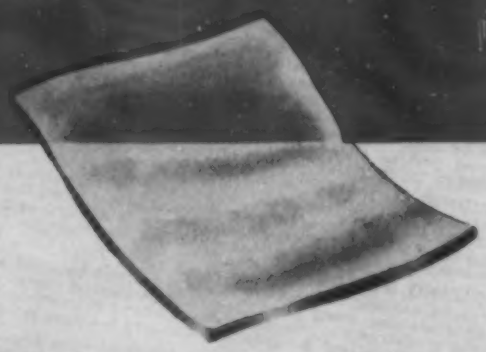
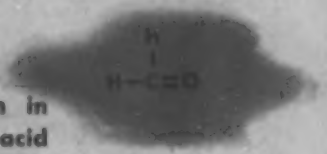
Metaplast Process Patented and Licensed

METAL PLATING ON PLASTICS

# CHEMICALS FOR PLASTICS AND RESINS



## FORMALDEHYDE



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## PARAFORMALDEHYDE

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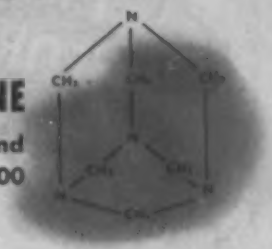

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(Methylene Disalicylic Acid, Technical)

Combines the reactive carboxylic acid groups with the phenolic groups in the same molecule, making it possible to combine the versatility of the alkyd type resins with the chemical resistance of the phenolic type. M. D. A. may be used to produce modified phenolic resins which can be cooked into varnishes by the usual methods to produce fast-drying paints and varnishes of improved chemical resistance.

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Aico

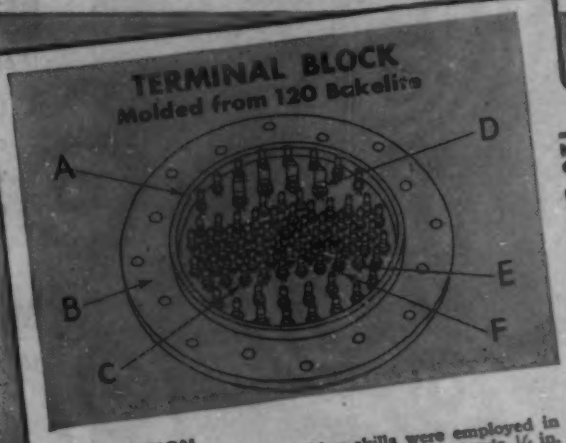
PRECISION MOLDED FOR ACCURACY

25th

# EXTREME ACCURACY *Required in Molding Plastic Terminal Block*

PRODUCING this Thomas & Betts terminal block in plastics was not a job for novices in the plastic molding industry. Seventy-nine metal inserts are successfully molded in symmetrical arrangement into an area of less than eight square inches!

Demanding intricate mold design and extremely close tolerances, this part is a noteworthy example of Aico precision molding and the results which are made possible by Aico's 29 years of experience with all molding methods and materials.




120 BAKELITE TERMINAL BLOCK

**MOLD DESIGN**
Aico's most precise mold making skills were employed in tooling this intricate mold. Circular rim (A) extends ¼ in. above flat wall section (B) on both sides of the part, enclosing the area which holds 79 metal inserts (C). The inserts (D) extend through the plastic wall section (B) and require matching holes in both parts of the mold. These holes in the mold must line up perfectly to avoid bending or shearing off inserts when the mold is closed. Diameters of these holes must be held to close tolerances to prevent flash on the exposed part of the insert (E). Small numbers (F) are molded in for easy identification of connections.

**MOLDING MATERIAL**
120 Brown Bakelite (one of the better grade general purpose phenolics and Navy-approved for electrical parts) offers the required electrical properties, dimensional stability, and resistance to heat. Finish is clean and lustrous.

**MOLDING METHOD**
Transfer molding is the only practical method to mold a part containing many small inserts. This method permits closer tolerances and eliminates displacement of inserts because the plasticized material is forced into a closed mold.

**This is the 25th in Aico's plastics application series. A request on your letterhead will bring copies of the complete series, Nos. 1 to 25.*

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29th Year

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Pumps and control equipment for hydraulic systems, perfected by PESCO for wartime aviation, today open the way for many new and more efficient uses of Pressurized Power.

PESCO Equalizing Flow Dividers are among the equipment that now makes possible new Pressurized Power applications. These precision equalizers were perfected to synchronize the operation of wing flaps and landing gears. They divide a single hydraulic flow into two or more outlet flows of equal or proportional volume. They feature a highly efficient gear-type design with simplified construction. Pressure limits range up to 2000 p.s.i. in models that vary from 3.8 to 7.7 pounds in weight.

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WITH
## CHEMACO ETHYL CELLULOSE
## FOR FLASHLIGHTS

Very often a molder teams two Chemaco plastics in one article to achieve the best results. Bright Star Battery combined Chemaco Cellulose Acetate with Chemaco Ethyl Cellulose to produce a flashlight housing and lens that have to take abuse. The combination of these materials has produced an article with impact strength at low temperatures, resistance to water and moisture, plus a tough, wear resistant case.

The lens is made of crystal clear Chemaco Cellulose Acetate. This tough plastic provides a virtually shatterproof lens having a high refractive index that supplies maximum light transmission.

This happy combination, or others proved by extensive military and industrial use, may be the answer to your conversion to plastics.

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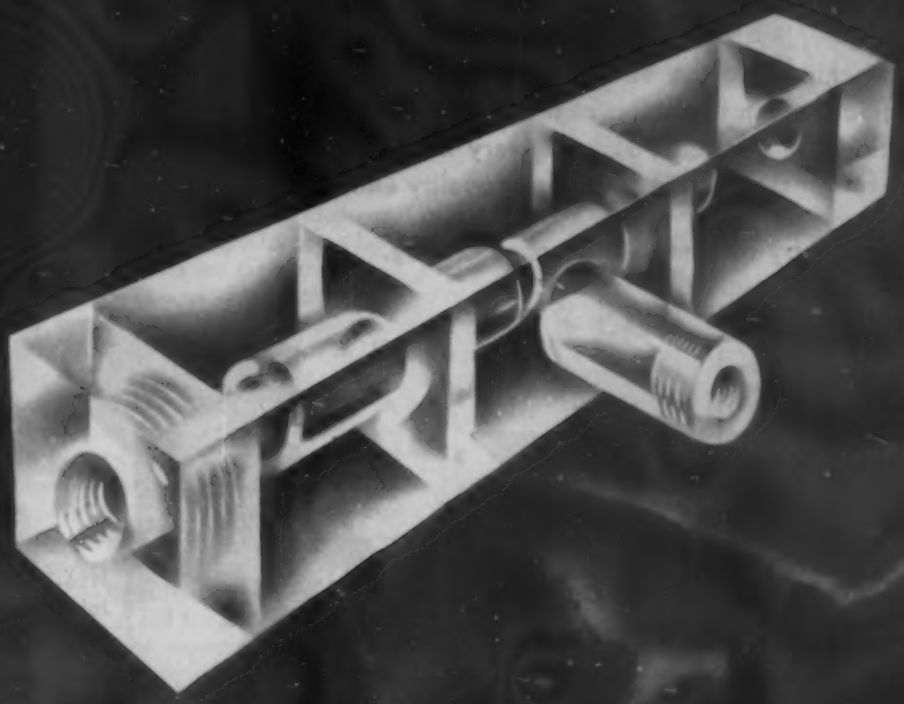
**Berkeley Heights, N. J.**

Branch office in Cleveland

# From model to production



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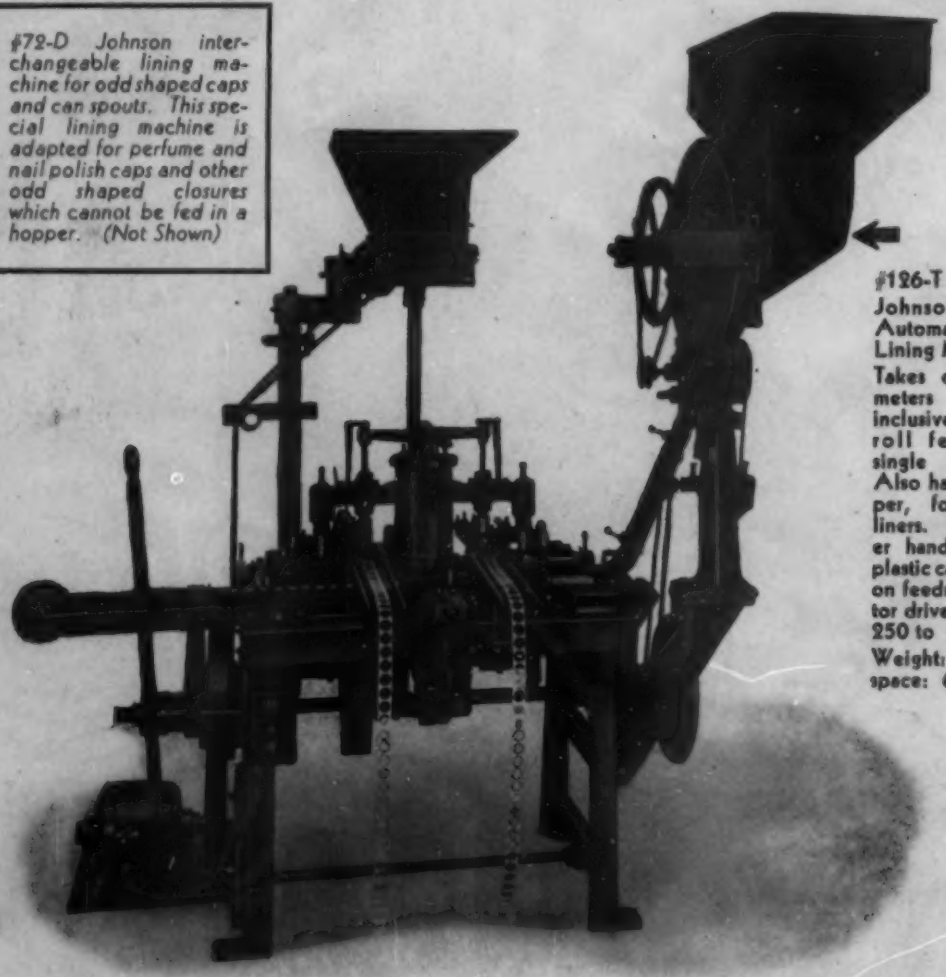
**WE manufacture a complete line of automatic and semi-automatic equipment for die cutting and inserting liners into closures.**

**Our machines handle all types of lining materials including cork and papers. There is a machine to handle every size closure from 89 millimeters down to the smallest size made.**

**Johnson machines are the acknowledged standard of quality for this work. You will find them in the plants of the largest closure manufacturers. We have been making them since 1901 and every machine carries our unconditional guarantee for greatest economy, highest quality and maximum production.**

**Send for free copy of complete 80 page catalog.**

*#72-D Johnson interchangeable lining machine for odd shaped caps and can spouts. This special lining machine is adapted for perfume and nail polish caps and other odd shaped closures which cannot be fed in a hopper. (Not Shown)*



**#126-T**
**Johnson Interchangeable Automatic Screw Cap Rotary Lining Machine.**

**Takes caps from 18 millimeters to 38 millimeters inclusive. Two automatic roll feeds and dies for single or double liners. Also has cork feed and hopper, for inserting pre-cut liners. Automatic cap feeder handles both metal and plastic caps. Automatic stops on feeds save material. Motor drive and clutch. Speed: 250 to 300 caps per minute. Weight: 1800 lbs. Floor space: 6' x 3'.**

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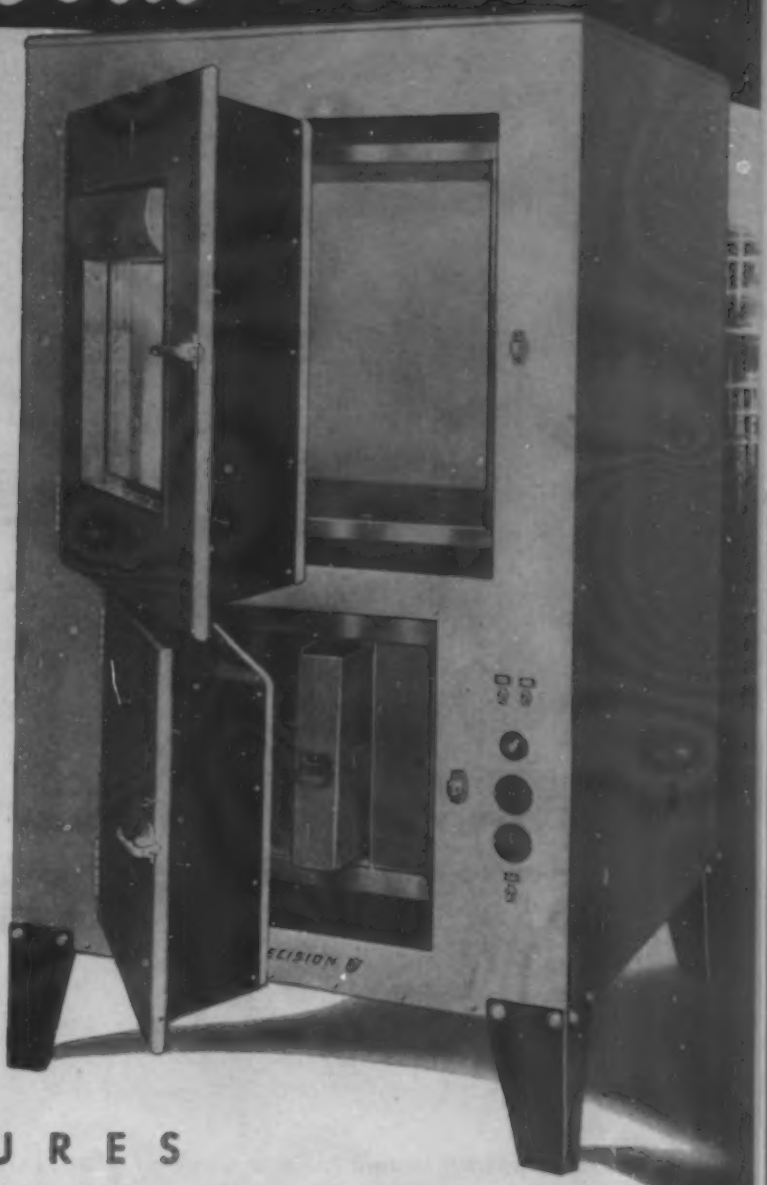
**8 cu. ft. or 1 cu. ft. capacity**
**Temp. range —90° F. to +220° F.**



This "Precision" Vari-Temp Cabinet operates with dry ice and was designed and developed to satisfy all the cold test-conditions encountered and required by present day testing techniques, from —90° F. to +220° F. The vertical cabinet design with the large door provides easy access to a spacious chamber, sufficiently large to hold the various types of apparatus used for the tests. It will also accommodate the apparatus used in making the Young's Modulus test of natural and synthetic elastomers at normal and sub-normal temperatures, to ASTM D-797. The apparatus and specimens under test are readily visible at all times since there is no frosting or condensation on the surface of the observation window.

The incorporation of a heating unit in this cold chamber allows a full temperature testing range of from —90° F. to +220° F. The temperature is held at ±1° F. by individual regulators for the low temperature tests and for the high temperature tests.

Ample space has been allowed for the placement of apparatus in the cold chamber, a full 8 cu. ft. being available. Special apparatus can be mounted by means of holes, which can be drilled directly into the outer shell when necessary, as well as over the entire area of the bottom of the test chamber.

## FEATURES

This "Precision" Vari-Temp Cabinet is of extremely rugged construction throughout, and is made to give years of service. The special construction and arrangement of the ducts prevent the carbon dioxide gas from entering the specimen test chamber. Mechanical convection provides uniform temperature.

Thermal losses are kept at a minimum by completely insulating the inner wall from the outer wall.

Metal plates 4" wide, the height of the chamber, are centered on each side of the rear, and on the top, to provide facilities for mounting the apparatus from any of these positions.

Insulating tubes prevent dissipation of cold from the inner chamber.

Heavy gage tinned copper has been used in all parts liable to corrosion due to condensation.

All temperatures are controlled thermostatically, one thermostat being provided for low temperatures, and one for high temperatures.

This cabinet is attractively finished in anti-corrosive aluminum.

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*"Everything in this room is made of glass, except the windows. They're plastic, of course."*

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When the Boys
Think We Are Worth
A little Ribbing.
More Power to Them.
Because This Business
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Technical
It becomes Painful.

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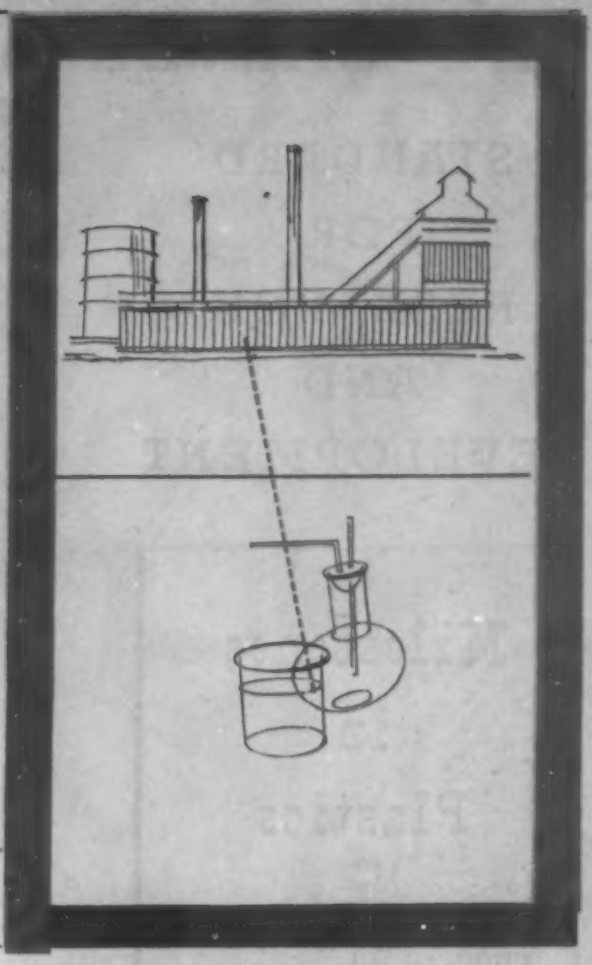
From the coke ovens

*clear*
*through*
*to*
*the*

synthetic resin maker...

**KOPPERS**

is watching quality...



**Phenols** (tar acids) are derived from coal tar which is obtained from byproduct coke oven plants.

Most of the coke oven plants in America were designed and built by Koppers.

This company also designed and built a great deal of the equipment which is used to recover and refine the coal tar, and to produce the tar acids. It also operates many of these refining plants.

So, Koppers has its finger constantly on the whole process which finally results in phenols which go into plastics manufacture, and will be glad to work with your chemists in connection with plastics materials.

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**KOPPERS PHENOLS** are available with melting points of 39° C. and 40° C., and also as 90% phenol with about 10% ortho cresol, and as 82% phenol with 2% to 3% meta-para cresol and the remainder ortho cresol.

**KOPPERS CRESOLS** are available as pure ortho cresol, melting point 30.4° C., 95% meta-cresol, meta-para cresol, and many blends of the three with some phenol and xylenol content.

**KOPPERS CRESYLIC ACIDS**—tar acid content not less than 99%, composed of cresols and xylenols are available, made to all specifications. Symmetrical 3,5 meta xylenol with melting point not less than 60° C. is also available.

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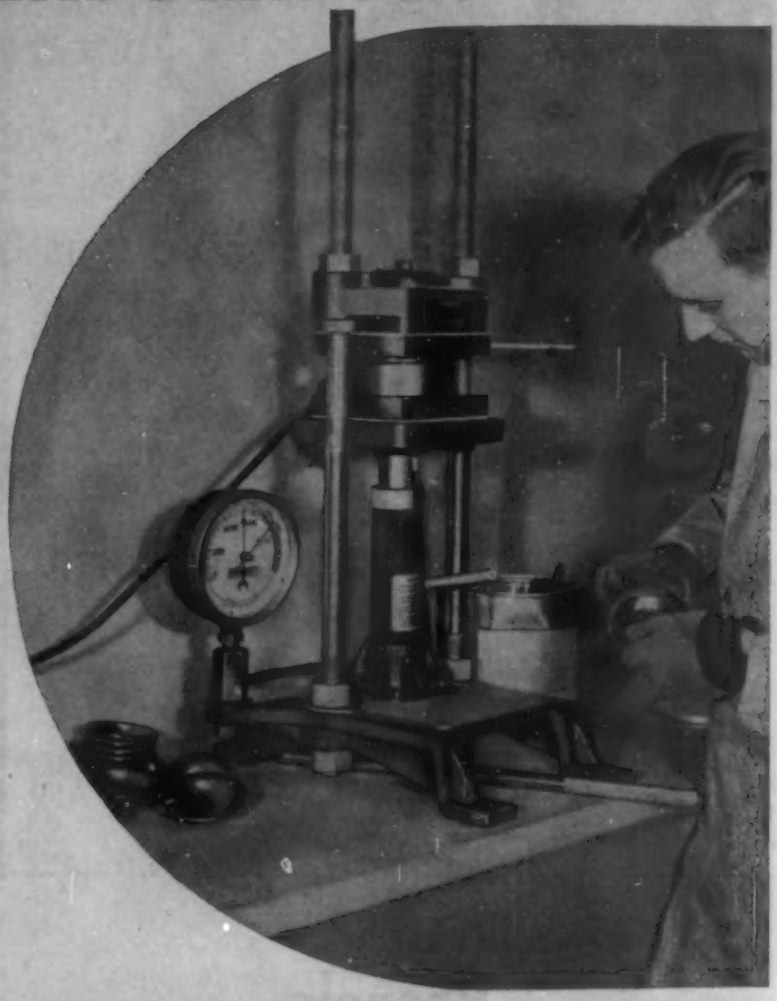

## Milestones in Plastics

In 1831, natural monomeric styrene was first isolated from storax balsam. It is recorded that Simon in 1839 noted that the sun's heat polymerized this compound. Despite this early discovery, polystyrene is a comparative newcomer to the molded plastics industry. In molding compounds and other useful forms, polystyrene has proved its usefulness in a wide variety of applications. It is one of the many plastic materials that owe their rapid development and improvement in recent years to plastics research. The progress in plastics is due to continuing experimentation in the laboratory.

Back in 1927 the first Carver Laboratory Press was sold. Since then the Carver Press has become essential equipment in thousands of laboratories, in industrial organizations, government bureaus, public institutions, technical schools and universities. This acceptance has been due to the accurate and dependable performance of the press, and to the many services it renders. Known by its characteristic design, the Carver Laboratory Press is standard

- for making quick and accurate small-scale pressing tests.
- for development, research and instruction work.
- for testing single cavity molds.
- for preparation of samples.
- and even for small-scale production.

The Carver Laboratory Press is small, compact,

- has a pressing capacity of 20,000 lbs.
- weighs only 125 lbs.
- operates under self-contained hydraulic unit, giving any precise variations in pressure that may be desired.
- large accurate gauge of finest construction is rigidly mounted on base.
- special gauges are available for low pressure work.

Carver Press accessories include electric and steam hot plates and test cylinders or molds. Standard interchangeable accessories are available for general research—cage equipment, bearing plates, filtering equipment, etc. Send now for latest catalog.

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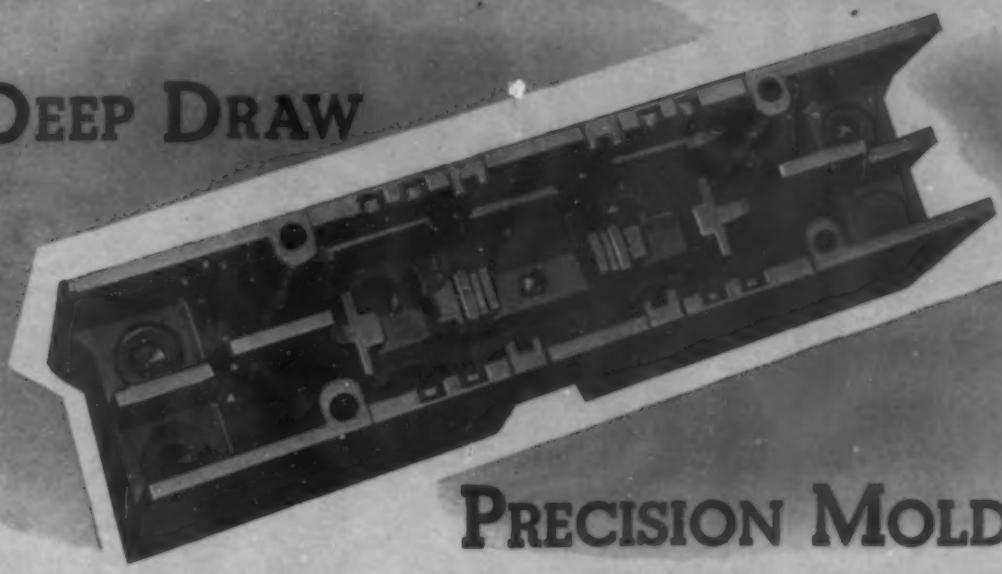
# MEGATHERM Speeds up

## DEEP DRAW



## PRECISION MOLDING

Notice the complex interior of this large-size plastic base for a multi-circuit breaker . . . a finished piece measuring 7" x 2" x 1⅝" . . . draw depth 2¼".

To assure dimensional constancy and to accelerate production, twenty preforms of wood-flour-filled bakelite are simultaneously preheated with MEGATHERM . . . and at one time four finished parts come from the press with a high gloss, almost completely free from flash. Other methods of preform heating previously used on this job brought no success.

This is another typical case showing how MEGATHERM reduces curing time by quick, uniform through-heating of preforms.

High-speed through-heating accelerates the free flow of plastic into all recesses of the mold and permits reduced molding pressure.

Reduced pressure minimizes wear on mold surfaces . . . and accordingly helps to hold close tolerances in all dimensions of the part.

Use of MEGATHERM thus speeds up the output of high standard plastic products and helps to increase life of molds as well as to reduce rejects and unit costs.

Save time, labor, money and molds . . . avail yourself of the great improvements in quality and quantity of output that MEGATHERM can bring to you.

***See this compact, portable 1 KW MEGATHERM***

. . . a highly versatile unit . . . ideal for incorporation into molding presses or into special production set-ups. A foot-pedal switch opens the oven door, leaving operator's hands free to insert the work. Flexible output circuit permits processing a wide range of load weights, heights and materials. Write for complete details now.

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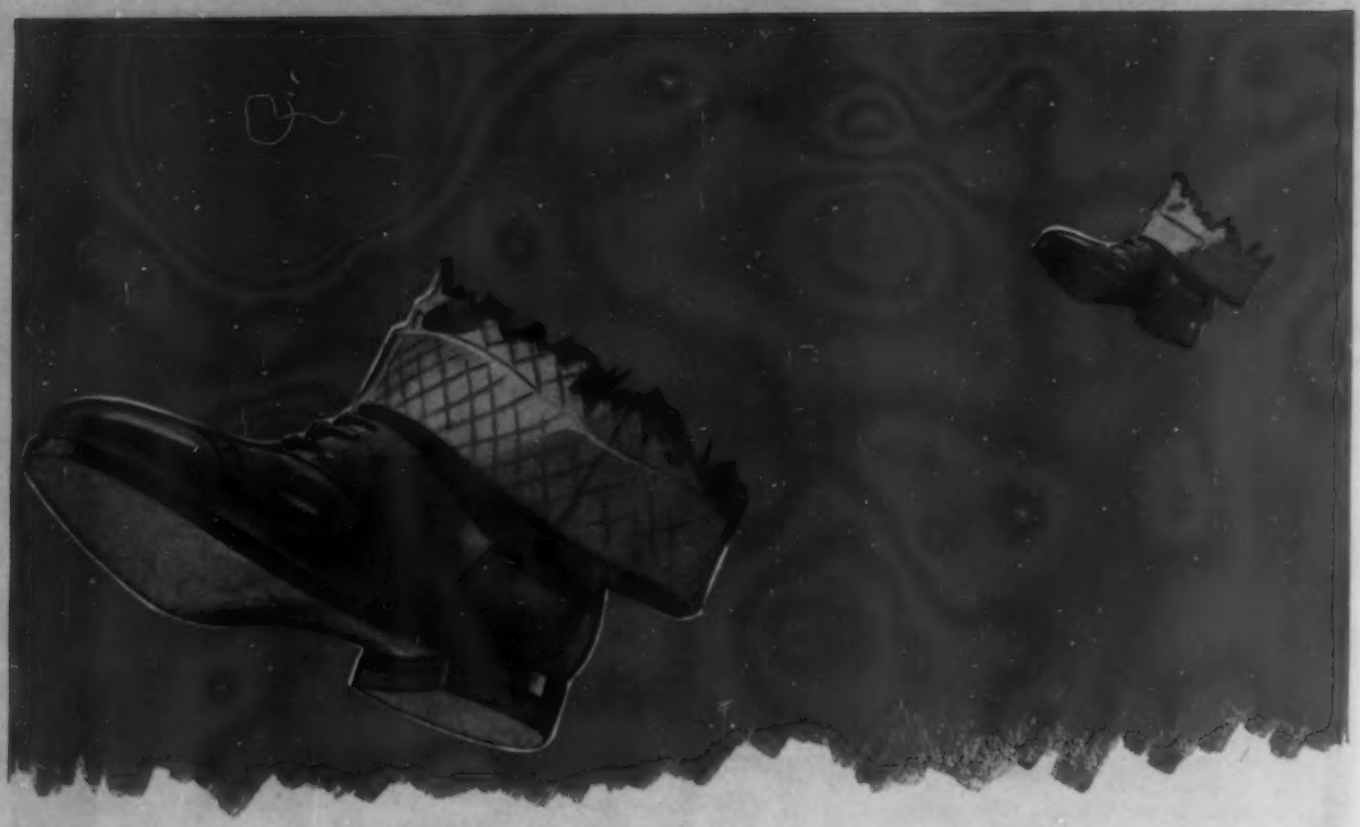

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**A reserve of new, low molecular weight mono- and dibasic-acids and their esters is waiting in our research laboratories for a multitude of peacetime applications, some already in commercial production *Now*.**

**For example: a new development for the vinyls provides a long-wearing, non-skidding shoe sole, impervious to oils and grease. *Not* a substitute for anything but a *new* use which awaits only the release of certain vital materials to become an unlimited operation.**

**Emery's Plastolein X-55 is ready for its part in this and similar assignments. Compatible with the vinyls, it imparts good low-temperature flexibility, coupled with excellent ageing characteristics.**

***Note:* PLASTOLEIN X-55 IS AVAILABLE IN LIMITED COMMERCIAL QUANTITIES**

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A glycol ester of Pelargonic acid ($C_8H_{17}COOH$) which is compatible with a wide variety of resins including nitro-cellulose, other cellulose base plastics, and the vinyls.

Plastolein X-55, for example, has continued to perform satisfactorily as the plasticizer in vinyl bed crib-bing where resistance to staining agents and good ageing characteristics are important characteristics.

# EMERY INDUSTRIES, Inc.

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MODERN PLASTICS
VOLUME 23 OCTOBER 1945 NUMBER 2

# Two decades... in the plastics industry

MODERN PLASTICS, which was first placed in the mails in October 1925, as "Plastics," may be said to be the diary of the plastics industry. On its pages are to be found an account of one of the best tales in the literature of American industry—a true story of resourcefulness, patience, invention, ingenuity, trial and error, and crowning success. The story has been told by those who made it come true, for from the first the entire industry has offered generous support to the magazine. This 20th anniversary is a fitting time to pause to consider the growth of the industry and the participation in it of this publication.

## 1925—in the beginning

When the forerunner of MODERN PLASTICS first appeared in 1925, five plastic materials were being produced commercially—shellac, bituminous plastics, casein, cellulose nitrate and phenolic. Cellulose nitrate was the focus of attention, at the moment its greatest outlet being toiletware. But phenolic resins were the materials destined to forge ahead to new records of production and application.

Even at this time, firms with limited molding experience saw promise in plastics products manufacture and were purchasing equipment. A series of articles dealing first with hand-molding hydraulic presses and later with semi-automatic machines served to introduce available units to the budding entrepreneurs.

The uses for plastic parts were increasing and specific fields were being earmarked for attention. "Radio presents limitless possibilities," headlined the second issue. Electrical uses for phenolics were surveyed. The February 1926 issue carried the first review of the many plastic applications in the motor car.

## 1930 to 1939—years of development

By 1930 it was clear that the industry was starting out on a major phase of development. The early part of the decade was marked by the introduction and small-scale production of new materials. And there was a steady widening of uses, made possible by the innovation of improved molding techniques. Plastics were adaptable to streamlined design and were recognized as materials which could be easily formed into modern shapes.

*Thermoplastics and injection molding*—Thermoplastic materials such as cellulose acetate, the vinyl resins, the acrylics and styrene, provided an incentive to molders and machine manufacturers to make practicable injection molding. Although this molding method had been known for 20 years, a heat-stable material had been needed to make it practicable. Offering an economical way to mass-produce intricately shaped small parts, injection molding led to the production of hundreds of thousands of novelties, jewelry items and industrial parts.

Highly plasticized thermoplastic sheeting developed in its many forms and uses late in the thirties. Elastomeric plastics began to appear as safety glass interlayer and packaging film. In the leather and luggage fields thermoplastic coating, which was calendered on fabric backing, proved durable and popular.

Continuous extrusion molding, stimulated by the advent of thermoplastics, seemed to "catch the imagination of the

**IT is with deep pride, not unmixed with awe, that we of Modern Plastics inaugurate the third decade of service to the plastics industry. After four years of war, the constructive forces of research, science and industry can again be dedicated to the rebuilding of civilization. In this coming period of growth the plastics industry has an unparalleled opportunity for development—and a tremendous responsibility, too.**

**Since 1925, this publication and its predecessors have kept pace with the plastics industry, reporting, interpreting and, wherever possible, anticipating its requirements. The pledge we made the industry when we assumed ownership in September 1934 is renewed today—"to express honestly and fearlessly, such opinions as may be judged beneficial to the unrestricted and sensible growth of the industry, to present practical information regarding the manufacture and distribution of the industry's products, and to collate and coordinate these efforts for the greatest benefit."**

**We shall maintain our basic policy of advocating only sound economic usages of plastics, of directing attention to conditions which jeopardize the industry's welfare and of suggesting remedial action when it is needed. We shall actively support any educational or promotional program sponsored by recognized industry groups, and fight with every available means any attack on the good name of plastics.**

Charles A. Breskin

plastic fabricators overnight." Extruded trim, breaker strips, and rods and tubes for numerous applications were developed, as well as the fine denier monofilaments which entered competition in the ranks of the synthetic fibers.

*Thermosetting materials and more molding developments*—The most important addition to the thermosetting resin group during this period was urea resin. These resins in white, pastel and translucent forms were pounced on by the lighting, radio, clock, sign and display industries.

"Transfer Molding Broadens the Field" announced MODERN PLASTICS in 1935. This technique made possible the molding of fragile metal or glass inserts as well as intricately designed plastic parts—a boon to the electrical and communications industries.

The first striking change in compression molding came during these important years with the development of fully automatic high-speed compression molding presses.

"I saw an automatic compression press," wrote the Editor, E. F. Lougee, in 1939, "turning out perfect molded parts from a multi-cavity mold, hour after hour, with no more attention required than to put out a new drum of material when one was exhausted and remove drums from the press when they were filled with molded parts."

And not only were changes being made in the compression method. Mr. Lougee was also able to write, "I saw phenolics and ureas being injection molded with all the speed and facility of production usually associated with thermoplastic materials." This was the first hint that injection molding of thermosetting resins was becoming a reality.

Attendant with the development of speedier molding methods and more varied materials was a growing interest in the place for plastics among structural components. This led to research and improvements of laminates and weather-resistant plywood. In 1938 the magazine published a report prepared by the National Bureau of Standards at the request of the National Advisory Committee for Aeronautics on "Plastics as Structural Materials for Aircraft" in which the first molded plywood fuselage was reported.

*Technical section added*—More technical information was needed by the industry as a result of the forward strides in materials and industrial applications. So in 1936 the publishers invited Dr. Gordon M. Kline of the National Bureau of Standards to edit a Technical Section for MODERN PLASTICS magazine.

To further serve the industry as a source of information on plastics a Readers' Service Bureau was established by MODERN PLASTICS. This department now handles approximately 1000 requests each month for trade and technical data concerning plastics.

*Plastics were serving most industries*—By the end of the thirties plastics products were being tried out in almost every peacetime industry. New crack trains, ocean liners and dirigibles were described and those plastic applications which contributed to more luxurious decor were given special attention. The automobile shows were reported each year and it was noted with satisfaction that plastic applications were increasing. Moreover, the magazine suggested other places where plastics could contribute to better automotive performance.

Increasing use was being made of plastics in the home. "Refrigerators are no longer cool to plastics" quipped the

***First in October 1925, again in October 1930, January 1934 and September 1934, the name of this magazine underwent modification. The covers of the issues in which these changes occurred are reproduced on this and the succeeding page***

magazine about this important field of application. In architecture, both interior and exterior, leading architects spoke up for the new materials, using them for laminated surfaces, lighting and built-in furniture.

Plastics were also used for machine parts, abrasives, electrical parts and protective coatings; for notions and novelties; office equipment and toys. Plastics were considered so important a fashion adjunct, that a "Plastic Modes" section was published regularly in the prewar issues of the magazine.

*The Industry is brought to the people*—Wide national attention was focused on the plastic industry's broadened place in the American scene through the medium of the Annual MODERN PLASTICS Competitions which developed from a collection of "hundreds of entries" in 1936 to over 1000 entries in 1939. Later competitions included over 3000 entries. Now that the war is over, the magazine is laying plans to hold these competitions once more.

Millions of persons were made aware of plastics as the winners were gathered into an exposition and shown in leading retail department stores across the country. Other exhibits which brought plastics to the people were the "Magic of Modern Plastics" at the Smithsonian Institute, the 1940 "Plasti City" showing in the Department of Commerce foyer in Washington, and those at Yale University; the Museum of Modern Art and the New York City Information Center.

Building up public awareness, too, were the educational motion pictures shown in schools, clubs, business and civic groups. These included *Modern Plastics Preferred*, *The Magic of Modern Plastics*, and *This Plastic Age*.

*Modern Plastics Catalog and Encyclopedia*—Reflecting the growth of the industry, the PLASTICS CATALOG appeared in 1939 as a complete reference work distinct from the annual special October catalog issue which had been published since 1936. Under the continuous editorial direction of Dr. Gordon M. Kline, this book has expanded from 332 pages in 1936 to an 1178-page encyclopedia in 1945. The Plastic Properties Chart in the latter book shows that the five plastics of 1925 have now become 28 versatile industrial products.

### The war years

American industry, a high geared machine turning out refrigerators, automobiles, vacuum cleaners, furniture and apparel—the implements of peace—was going top speed in 1940. It was not until Pearl Harbor that the brakes were jammed on and the machine was used almost entirely for war. The plastics industry, part of the total industrial pattern, followed along these same lines.

In January 1942 the magazine's "Portrait of an Industry" surveyed the position of the plastics industry at the outset of World War II. Materials manufacturers, molders, fabricators and government authorities analyzed the situation and outlined a program for total victory.

New economic problems arose as the young industry was faced with the need for cost estimates in order to obtain government contracts. The magazine issued separate studies on such problems as "Representative Cost Finding Systems in the Plastic Industries" and "In Process Factory Cost Accounting."

As first thermosetting and then thermoplastic materials were placed on allocation, and as one order followed another from Washington, explanation of governmental directives

1934

*Since September 1934, the covers of Modern Plastics have changed but slightly as can be seen by comparing the front cover of this the 20th anniversary issue and the cover of the first issue to carry the name of Modern Plastics*

was needed. A Washington Bureau, directed by R. L. Van Boskirk, was inaugurated by MODERN PLASTICS to report on latest national and world developments of special interest to its readers. Out of the "Washington Round Up" column and the special sections on government orders and regulations, grew the WASHINGTON NEWS LETTER. To satisfy an increased demand for spot news coverage the weekly PLASTICS NEWS BULLETIN was brought out in 1944.

*Engineering section also added*—One reaction to military demands which "stripped plastics of decorative and novelty appeal and called for cold utility and unfailing performance under fire," was an augmented concern with mechanical properties. This was reflected in increasing technical and engineering studies. The demand for more engineering information as new techniques of molding and fabricating were developed was met in 1942 by the addition of an "Engineering Section." Frederick B. Stanley joined the staff as editor of the section.

*War-born developments*—Metal and rubber shortages accelerated developments of plastic replacements. Manufacturers found that there were many advantages in using these materials, such as lightweight, corrosion resistance and ease of fabrication.

Cast phenolics resigned their decorative role to replace metal by stepping into the retooling program, where they took the place of zinc alloys in forming dies and patterns for sand casting for aircraft, oil drilling and other industrial uses. Thermoplastics and pressed resin treated wood also aided in tooling for gigantic war production. A permanent place was assured these materials in low-cost tooling programs.

Replacement of rubber with thermoplastics was found to have its advantages, too. Manufacturers who had struggled with limitations of color, flammability and the fact that the natural rubber was adversely affected by extremes of weather, now found a material which had few of these shortcomings. The use of plastics as wire insulation is an outstanding example of a substitution destined for carryover into peacetime.

Rubber shortages also led to increased use of synthetic coatings for fabrics. Plastic-coated water-repellent fabrics which replaced oil and rubber finished materials were reviewed in articles on "Flexible Coatings for Textiles" and "Replacement of Rubber Coated Fabrics."

*Low-pressure techniques*—Hitherto unattainable strength in proportion to weight was offered by glass-reinforced low-pressure laminates—a development which had been hastened by the need for lightweight aircraft parts. Plastics could at last be seriously evaluated as structural materials. Seven articles in the May 1944 issue of MODERN PLASTICS presented a concise and authoritative account of the development and handling properties of glass reinforcements and also discussed low-pressure resins and molding and laminating techniques. Production of streamlined chairs, lightweight luggage, and prefabricated bathroom and kitchen units indicated the potential range of application of structural and semi-structural products in a peacetime world.

Other new construction combinations were dense, stiff faces separated from and stabilized by thick light cores of foamed or expanded resin. Fabrication advantages stem from molding integral sections in one operation. Civilian plane fuselages, small boats, automobile bodies, furniture and prefabricated housing parts are expected to be made of this type of combination material.

Another structural material which advanced during the war period to unparalleled heights was resin-bonded plywood. Construction of prefabricated temporary structures depended in large part on plywood for panels and flooring and for beams, arches and high-strength members. In small naval and coast guard craft and in aircraft there was maximum use of molded plywood parts with consequent improvement of bonding resins with advanced molding properties.

A resorcinol resin was announced in the December 1944 issue of MODERN PLASTICS. This resin solved many difficulties in assembly gluing of wood veneers, or resin-bonded plywood parts by curing rapidly under nearly neutral conditions. New resinous adhesives were also developed during the war years for bonding metals to themselves and to other materials.

Postforming, the method of shaping flat laminated sheet material at the point where formerly they were considered definitely thermoset and impossible to remold or shape, was a molding innovation of 1943 as reported in the August issue. The new method offered still another way to shape large objects in expensively and rapidly on wooden molds.

*Electronics*—Electronics, which had its meteoric rise during the war, had a twofold effect upon the industry. Plastic materials were important to electronic and radar equipment because of their dielectric properties, and electronic molding equipment was of startling significance to plastics product manufacture.

Layers of secrecy swathed the war-born new materials such as vinyl carbazole, the silicones and styrene derivatives which were able to handle high-frequency currents. The elastomeric styrene derivatives are utilized not only for electrical equipment but also for gaskets, tubing and other products where pliability under extreme heat is important.

Electronics was first allied with plastics manufacturing processes when high-frequency curing was used in preheating or speeding up gluing of plywood laminations and molded plywood. In 1943 a sweeping advance in the molding of thick sections of molding materials was made when a method for preheating thick molded sections by use of electrostatic fields was announced in the September issue of MODERN PLASTICS. High-frequency curing was followed by electronic welding of thermoplastics, which provided a quick, easy way to join edges and eliminate seams.

*Synthetic textiles*—Synthetic fiber development came to the front with both finer and larger monofilaments which offered greater elasticity, tensile strength, resistance to mildew, acids and extremes of weather. Control of luster, color and stretch having reached a new high, predictions were made for finer peacetime apparel and decorative textiles. Finishes were developed to proof materials against weather, flame, creasing, acids, shrinkage, loss and glaze and color. All this was reviewed by the magazine in a series of articles on synthetic textile development.

## Turning to peace

Now that the "tomorrow" everyone spoke of so glibly has become "today," attention of the industry is turned not only to the problems of design and production for peace but to education and merchandising as well. Informative labeling, consumer bulletins, proposed exhibits engage the attention of the industry and this magazine.

In studies of important markets from the standpoint of the manufacturer, the designer and user, this publication is examining plastic materials as they affect peacetime electrical, furniture, lighting, automotive, home appliance and industrial fields. The outlines of the things to come are now foreshadowed on the pages of MODERN PLASTICS magazine. It is a future which offers the participant a stimulating and profitable role as a contributor in what American industry is doing to bring about better living.

# I don't know . . . . . says the average salesclerk when queried about plastics. To overcome this ignorance, as revealed by an impartial retailing survey, there is need for point-of-sale education—informative labeling emerging as the most direct and effective means of reaching the widest consumer audience.

by ALFRED AUERBACH

Will it chip? I don't know.
Will it break? I don't know.
Is it color fast? I don't know.
Is it flammable? I don't know.

I don't know. That's the answer you get a great deal of the time if you go out on a shopping tour to see how much knowledge the average retail salesperson has about plastics products. We know, because we've just completed such a tour of 30 stores, both big and small, in and around the New York City area.

It is an old saw that the retail salesperson is no walking encyclopedia of knowledge, and that he can't answer many of the questions that a restless and curious public puts to him. But he (or she) knows less about plastics than about wool, or rayon, or furniture, or bedding, or virtually anything else on sale in a retail store carrying a wide and miscellaneous assortment of merchandise. The batting average is pretty nearly zero.

## Impartial study of retailing situation

Let me tell you a word about the nature of our retail study. We were out to make an unbiased, fact-finding survey of the manner in which the retail salesperson deals with questions about plastics. We had no fixations, no axe to grind, and we didn't set out to prove anything. Nor did we seek answers to technical and highly involved questions. We tried to find out how much the average salesperson knows about plastics. Can you boil it? Will it break? Is it color fast? Will it chip? These are typical of the questions we asked in all the stores we visited.

And we tried to find out if retail salespersons know more about one product than another. Does one kind of clerk know more than another? Would labeling help? If so, what kind of labeling? What other steps could be taken to improve matters in retail departments where such improvement is necessary? What, in general, is the attitude of retail executives toward plastics products?

Eight professionally trained shoppers—not plastics experts, just lay persons when it comes to plastics—visited stores in Manhattan, Brooklyn, the Bronx, Jamaica, L. I., and Newark, Paterson and Elizabeth, New Jersey. We actually bought merchandise. But after each transaction, we stepped aside and made a complete recording of our conversation with the salesperson. We visited small stores and big stores. We visited smaller cities, as well as the biggest city in the country. We covered department stores, variety stores, mail order stores, specialty stores and hardware stores . . . although department stores got the largest portion of our attention. In all, 30 stores were visited and 70 items (listed on page 102) ranging in price from 10 cents to $3.50, were purchased. We concentrated on four classifications of merchandise: housewares, notions, toys and giftwares.

We don't pretend that this was a scientific study, if the size of the sample is to be taken as the main measuring stick. But we soon got the feeling that it wouldn't matter if we saw three times as many stores. We would merely find the same facts repeating themselves over and over again. Later, we went back to speak to the executives of some of these stores, but that is another part of the story. First, let's talk about the conduct of the retail salesperson.

## Salespeople know very little about plastics merchandise

Nothing we could say would give you such direct insight into the performance of the average retail salesperson selling plastics products as you can get by reading the transcripts of our conversations with these clerks, which appear on page 101. These four reports were selected from a great batch as being characteristic of the lot. Some are better than others, but the average is very low. We have identified the stores in which each of these specimen conversations took place, but the executives of these stores needn't feel they have been singled out as particularly bad examples from among the 30 stores visited. Space limitations make it impossible to run all of these shopper reports, but from store to store, with just one or two exceptions, the same dismal situation was found to prevail.

When they don't say "I don't know," most retail salespersons give answers that are clearly guesses. Or they evade the issue entirely. Classic examples of inaccuracies can be found in the assurance that "You can't boil it because plastics will not stand any heat," or "Yes, you can clean this Lucite box with steel wool." And one must not overlook the bland comment of the girl at Woolworth's who parried questions with: "What do you expect for a dime?"

Enough about the salesperson. Suffice it to say he or she

***Alfred Auerbach, under whose personal supervision this retailing study was conducted at the request of* MODERN PLASTICS, *is an authority on retail merchandising. For twelve years editor-in-chief of* Retailing Home Furnishings, *he resigned shortly after Pearl Harbor to become head of the Consumer Durable Goods Branch of OPA. He left OPA last year to set up his own organization, rendering market research, styling and merchandising services to manufacturers of home furnishings and household equipment.***

very often doesn't know and quite often doesn't care. They hand out inaccurate and misleading information unwittingly, and have prejudices and favorites that color their sales talk. For example, some prefer wooden handles for cutlery and are quick to say so. Don't blame them, for their lot is not too pleasant and they can't know everything about all the items they sell.

A refrigerator salesman may well be an expert on his product and a mattress salesman may be a walking authority on all matters pertaining to sleep, but the salesperson selling plastics products usually works in a department such as Housewares or Notions where hundreds of miscellaneous and diverse articles are sold. He can't possibly know more than a limited amount about them, and to obtain even a limited understanding he needs a considerable amount of help. *That help must come from store management and from manufacturers of the products.*

### Retail executives confused and skeptical about plastics

We returned to some of the stores we had shopped to call upon the buyers and the personnel directors. In each instance we carried with us the reports of the conversations which had been held with salespersons in the stores we were revisiting. The reactions of buyers and personnel directors were varied, and in some instances startling. Few, if any, seemed surprised at the poor performance of their salesfolk. "Everyone is so uninformed about plastics," said one of them complacently, while another exonerated his staff with the words, "We have different salespersons every day, you can't expect them to know everything." Most of the buyers, however, evinced a serious concern about the situation, but evidently felt that it was too complicated and involved a training job to be dealt with easily. "There are so many kinds of plastics," murmured one buyer a bit helplessly when approached on the matter.

The war left its imprints too, and stirred up many irritations and disturbances. You start talking to a buyer about salespersons and soon find yourself talking about manufacturers. Changes in specifications have jeopardized a good deal of the earlier faith that buyers had in plastics. "Plastics are ersatz products, they are on the way out," vouchsafed one buyer, while another offered the comment, "No one will buy a plastics product if he can get anything else." There is little doubt that misuse of plastics in recent years has engendered suspicion and skepticism in the minds of certain retail executives. It should be remembered that buyers, themselves, are too busy to develop more than a cursory knowledge of plastics, and they naturally lean to safe, sure "oldtimers" such as wood or metal if they find plastics are unreliable.

To counter this sentiment is an array of buyers who assert themselves in such glittering phrases as, "We're only on the threshold of the plastics age," or "Plastics are going to be the biggest thing after the war." Maybe—but don't count on too much technical support from these well-wishers either. As a rule, their convictions about plastics are founded on faith and not knowledge.

Most buyers know more than their salespeople about the qualities and characteristics of the various types of plastics, but it isn't really an extensive knowledge. If you know a buyer well enough he will confess, off-the-record, that he "never was much good at chemistry in school" and he wished that somebody would give him the full story about plastics in a few simple non-technical terms so that he could master it once and for all. Not finding this cellophane-wrapped capsule of knowledge conveniently available, many buyers have "boned up" on plastics here and there, so that they have a smattering of information on the subject.

### Buyers seek more "know how"

Buyers seek more "know how" regarding plastics but claim they can't get it very often. "The salesmen who call on us from plastics firms can't give us the answers," we were told by one buyer. Another said, "It seems as though manufacturers of plastics products have deliberately decided not to say what the product can or can't do."

Buyers are good merchants as a rule, and they can't help sensing good opportunities and bemoaning lost ones. Hence they speak with regret of the manner in which the great,

## STORES VISITED BY ALFRED AUERBACH ASSOCIATES DURING PLASTICS STUDY

**MANHATTAN:**
R. H. Macy & Co., Inc.
Woolworth's, 34th St., also 5th Ave.
Bloomingdale Bros., Inc.
Gimbel Bros.
Stern Bros.
Ovington's
Simpson Hardware
W. T. Grant Co.
Kress

**BROOKLYN:**
Abraham & Straus
Namm's
Fredk. Loeser & Co.

**BRONX:**
Sears Roebuck
Hearn's
Deutch Hardware
W. T. Grant Co.

**JAMAICA, L. I.**
Gertz Dept. Store
Montgomery Ward & Co.
Woolworth's

**ELIZABETH, N. J.**
Levy Bros.
Woolworth's
Goerke Dept. Store

**NEWARK, N. J.**
Kresge Dept. Store
L. Bamberger & Co.
Hahne & Co.
Woolworth's
W. T. Grant Co.

**PATERSON, N. J.**
Quackenbush's
Meyer Bros.

**WOOLWORTH'S**
**NEWARK, NEW JERSEY**

**May 18, 1945** **Decorative Accessories**

**Shopper selected a plastic flower holder and inquired from salesclerk if it was plastic and was told it was. The following questions were then asked:**

**1.—Will it break? Clerk: No, it is unbreakable.**

**2.—How can it be repaired if it does get broken? Clerk: It won't break.**

**3.—Will it scratch? Clerk: Oh, no, it doesn't scratch.**

**4.—Can it be cleaned with brillo or scouring powder? Clerk: Yes, if you want to but all you will need is soap and water.**

**5.—If not, how do you clean it? Clerk: Soap and water.**

**Saleselerk was very definite in her answers which were given enthusiastically.**

**R. H. MACY & CO., INC.**
**34th STREET & SIXTH AVENUE, NEW YORK**

**May 17, 1945** **Garden Accessory Department**

**Shopper approached a young man clerk and asked if they carried hose coupling. She was taken over to a counter on which many of them (all plastic) were displayed. Shopper picked one up and asked:**

**1.—Will it break? Clerk: No, they take a lot of hard wear.**

**2.—How do you attach it? Clerk: You take both ends of the hose that you want to join and stick each end into one side of this, then you flatten these (pointing to prongs) with the pliers.**

**3.—Can you use a wrench? Clerk: No, only the pliers.**

**Shopper then asked if he thought a metal coupling would be better. To this his answer was: "Yes, it would be sturdier, but we can't get metal ones."**

**OVINGTONS**
**40th STREET & 5th AVE., NEW YORK**

**May 19, 1945** **Decorative Accessories**

**Shopper went to the second floor and asked for plastic or Lucite cigarette boxes. Shopper selected one and asked the following questions:**

**1.—Will it break? Clerk: I don't think so, at least not like glass.**

**2.—If it breaks can it be repaired? Clerk: No it can't be repaired because if it breaks it usually cracks.**

**3.—Will it scratch? Clerk: No.**

**4.—Can I clean it with brillo or soap powder? Clerk: Yes, but soap and water is just as good.**

**5.—Is it flammable? Clerk: No, I don't think it is.**

**FREDK. LOESER & CO.**
**BROOKLYN, NEW YORK**

**May 9, 1945** **Toy Department**

**When shopper first asked for something in plastic toys clerk said, "We have none in stock." The shopper looked around and saw a large display of plastic toy telephones. When asked, this clerk said "Yes, they are a kind of plastic, a composition."**

**1.—Is this flammable? Clerk: I don't know but I don't think so, I'm not sure.**

**2.—Can I sterilize it? Clerk: I don't think so.**

**3.—Can I boil it? Clerk: I don't know but I hardly think so.**

**4.—If a child puts receiver in his mouth would the color come off? Clerk: It might, but we have had no complaints.**

**5.—Is it breakable? Clerk: I suppose it would break if it was hit hard enough.**

**GENERAL**

**This button is made of plastics. It is smooth, color fast. Will wear well in normal use. Remove before washing or dry cleaning. Do not touch with hot iron when pressing.**

**EDUCATIONAL**

**This button is made of a cellulose acetate plastic. It is one of the plastic family. Its surface is smooth. Won't discolor nor chip in normal use. Always remove before washing or dry cleaning. Avoid contact with hot iron when pressing to protect finish.**

sprawling, unorganized family of industries which trades under the heading of "plastics" is periodically jeopardizing public faith because, in most cases, there exists no precise line of control from raw materials sellers, to molder or fabricator, to store, to consumer.

Makeshift use of plastics for purposes for which they are not well suited was with us before the war and was with us to even a larger degree during the war. Criticize a buyer and he will criticize the manufacturer. In this instance, you can build a pretty good argument either way. Unfortunately, while similar abortive applications of other basic materials have appeared on the market because of wartime shortages, the case against plastics warrants special attention. So few consumers know anything about the field and its products, and prejudices are being established now that may take a long time to overcome.

### Labeling recommended as medium of consumer education

What curative steps can be taken to combat the confusion and ignorance? Clearly some regulatory and self-disciplinary measures are needed or else the plastics industry will never attain the sales position of which it is capable in a great many of the consumer goods industries.

### Purchases made

| | |
|---|---|
| Aprons | Frames |
| Airplane sets (toy) | Funnels |
| Bag ornaments | Glass |
| Bathing caps | Handles (toy) |
| Beverage shakers | Hose couplings |
| Boats (toy) | Knives |
| Buckles | Light switches |
| Buttons | Napkin holders |
| Buttons—blue | Salad sets |
| Buttons—green | Salt and peppers |
| Buttons—red | Screw drivers |
| Checkers (toy) | Shower curtains |
| Cigarette boxes | Spatula |
| Collanders | Strainers |
| Cookie cutters | Telephones (toy) |
| Flower holders | Vanity sets (toy) |
| Forks | Whistles (toy) |

There are a number of steps that could be taken to deal with the situation but the one that emerged from this study as the most direct and the most efficient is labeling. Informative labeling deals with the difficulty right at the point of sale. It tells the salesperson what he needs to know when he needs to know it. And it gives the needed information to the customer at the same time. Informative labeling is the most effective, single instrument that plastics manufacturers can use to counteract the broad ignorance of the properties of their wares. Surely, if the Grocery Manufacturers Association has found it desirable to embark on a vigorous program[1] on behalf of "descriptive labeling" for staple food products, it is not too much to hope that producers of plastics products do the same for their relatively new and only slightly understood merchandise.

Labels, of course, are not a new concept on the plastics scene. We examined the 70 items we had purchased and found that 12 of them had some sort of label or tag. Evidently, some manufacturers feel that they are discharging their labeling responsibilities quite amply when they tag a product "plastic airplane" or "plastic checkers." Others feel they have done all they need to when they use such brief incomplete expressions as "will not rust or stain" in tagging a knife. One manufacturer of a plastic-handled knife gave a great deal of information about the steel cutting surface, but nary a word about the plastic handle. Nevertheless, it is encouraging to find some stirrings and some efforts, even though they are only the scattered expressions of a handful of producers in a vast industrial scene.

### What should a label contain?

How informative should a label be? Should it contain negative facts? Should the labeling be undertaken by the raw materials producers, or by molders and fabricators? Should labels be educational and contain some technical information, or should they be extremely general and brief? Many of the questions have been under investigation by the

[1] Announced in May, 1945, this program of labeling every grocery product with adequate descriptions of its contents aims to help the homemaker buy accurately according to her requirements. A booklet, prepared to tell consumers what good descriptive labeling means and how it can work for them, will be distributed to leaders of women's groups and others with an interest in the promotion of good labels. Other publications and bulletins will be issued regularly by the Public Information Council of GMA, to keep both members and consumers informed of progress.

*Six of the seventy plastic items purchased in the course of this survey have been labeled with both educational and general labels*

**GENERAL**

**This knife has a smooth plastic handle. Will not chip in normal use and will not stain. Wash in hot *but not boiling* water and soap. Do not use scouring powder or abrasives. Do not let stand in water. It is non-flammable.**

**EDUCATIONAL**

**This knife has a handle of a cast phenolic plastic. It is one of many types of plastics, is smooth to the touch, will not chip in normal use and is color fast. It is not affected by fruit or vegetable acids or oils. Wash with soap and hot *but not boiling* water. Do not use scouring powder or abrasives. Do not let stand in water. It is non-flammable.**

industry for quite some time and have been discussed in this publication.[2]

We put these questions to 17 buyers among the stores we visited, as well as to several personnel training directors, and obtained from them a cross section of opinion that makes rather interesting reading. The following excerpts are direct quotes, virtually:

"Keep the labels short and to the point. No complicated names."

"Say what the product is good for and how to use it."

"Don't give us laboratory tags. Give us general, but not educational, tags."

"The chemical terminology means nothing to the public. Keep it unscientific."

"Some brand names, such as Lucite, Plexiglas, Lumarith, should appear, but not chemical terms."

"Make the labels attractive and easily read."

"The shorter the better."

Buyers wanted such questions as these answered on labels or tags: Is it suitable for contact with food? Can it be put into the oven? Can it be boiled? How much heat can it take? Is it affected by oils or acids? Will it chip?

Informative labels, to be most effective, should be simple and attractive. They should use relatively large type, the message should still be short and avoid complicated technical terms. They should be specific about what the product will do and they should also be specific about how to care for the product.

To illustrate these principles, with the help of the editorial staff of MODERN PLASTICS, we concocted 10 sets of labels, two each for ten different objects. We did this in order to tap the preferences of the buyers. "Do you prefer the one we have labeled 'general' or the one we have labeled 'educational'?" we asked 17 of them. Fifteen voted for the general type. In the accompanying columns you will find listed six of the ten different sets of labels on which we asked for a vote. Either type is superior to the general run of labels now used for these small items, and they are worthy of your careful perusal.

We ventured to approach Roger Woolcott, managing director of the National Consumer-Retailer Council, during the course of this study, because of the established interest of his organization in any labeling development. Mr. Woolcott was of the opinion that sound, informative labeling is probably more needed in the plastic industries than in any others for these very simple reasons: 1) Plastics are so new. 2) There are many different types. 3) People know so little of the difference between one type and another.

Mr. Woolcott was prone to favor the shorter of the two types of labels and thus cast his vote with the majority of the retail executives who were queried on this subject. But he added that he hoped brevity in itself would not remain the dominant consideration. Where plastics are used in conjunction with other materials, he pointed out that the labels should be complete and give the characteristics of all of the materials used in constructing the product. Thus, the label on a knife having a steel cutting surface and a plastic handle should carry information on both materials. Keep labels non-technical and stress performance values, Mr. Woolcott urged, saying these are the values consumers are interested in.

### Retail executives overwhelmingly in favor of labels

For the record be it said that with one exception every retail executive whom we queried on the matter voted in favor of informative labeling. The doubting Thomas said, "People don't read tags or labels," so if you are going in for them you had better make them attractive and very legible. Even our dubious friend would concede that smart terse labels have a greater chance of being read.

When we said that 16 out of 17 buyers voted in favor of labeling, we gave you only part of the story. Most of them endorsed informative labeling heartily, felt it is the most direct answer to the problem and would like to see labels employed on a much broader scale than anyone has yet visualized.

(*Please turn to next page*)

[2] "Information please," MODERN PLASTICS *21*, 275 (June 1944).

**GENERAL**

**This airplane is made from plastics. It is color fast, "feels" smooth and is non-toxic. To clean, dip in warm water or soap, or wipe with rubbing alcohol. It will not burn easily.**

**EDUCATIONAL**

**This toy airplane is made from a cellulose acetate plastic. It is one of the plastic family. It has all-through color which won't come off, is non-toxic and is smooth to the touch. Clean with warm water and soap or wipe lightly with rubbing alcohol. It will not burn easily.**

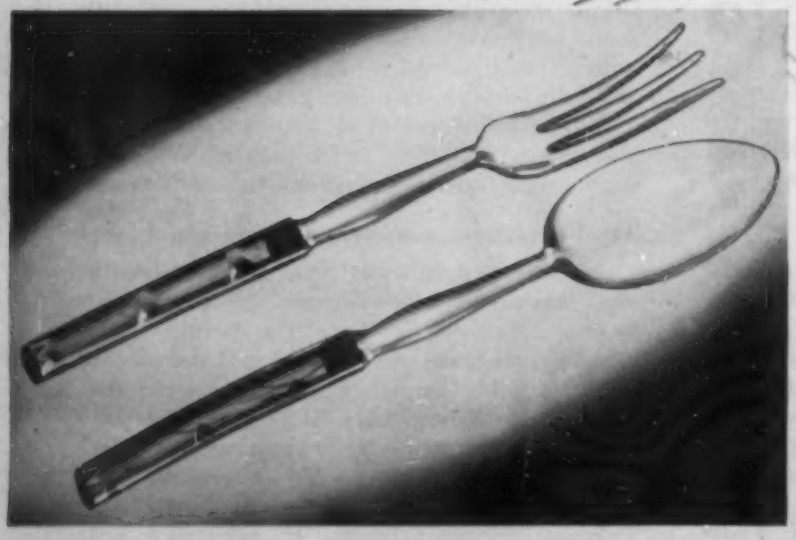
A persuasive vote in favor of the more "complete" label—which was kept pretty short, too—was raised by H. C. Ruette, buyer of housewares for the Kresge Department Store in Newark, and by Norman Richman, in charge of personnel and sales training at the same store. Said Mr. Ruette: "The general labels are too general, as if describing any plastic. If one of the so-called 'general' labels said 'flammable,' the consumer might think all plastics are flammable. The specific name would have a good psychological effect. I definitely prefer the educational label." Mr. Richman, interviewed separately, expressed the same sentiments. "The consumer must be educated. The name of the particular type of plastic on the label will permit the customer to ask questions, and as a result will improve the relationship between the customers and the salespeople."

### Some retailers attempt plastics education

Mr. Richman's faith in the competence of the retail salesperson to answer questions is not misplaced as far as his store is concerned. For Kresge's have apparently made very positive efforts to educate their salespeople on the properties of plastics. As a result our study found their salespeople answering our shoppers' queries much more intelligently and much more accurately than did the general average of clerks in the stores we covered.

The secret of the better performance of Kresge's salespeople probably lies in the use of a "merchandise information" bulletin (see the form on page 106) which the store has developed. These bulletins are, in actuality, questionnaire blanks dispatched to manufacturers, which, on their return, are distributed to the sales staff. There are two such forms, one for "soft goods" and one for "hard lines." It was rather encouraging to encounter this Kresge procedure. It indicated that the situation could be coped with, if stores and manufacturers made it their business to do so.

At Abraham & Straus', we gathered word of a lecture course that the store had been holding on plastics. Manufacturers have been sending representatives to speak to the salespeople before the store opens. Demonstrations and films helped to put the story across.



**GENERAL**

**This serving set is made of plastics. It is shatterproof, tasteless and odorless. Will not stain. Cleanse in warm water and soap. Does not break easily. Do not apply abrasive or scouring powder. Do not use with excessively hot food.**

**EDUCATIONAL**

**This set is made from a clear acrylic (methyl methacrylate) plastic, a member of the plastic family. It has no taste nor odor, won't break easily and is unaffected by oil or acids. Do not use with excessively hot food. Wash in warm water and soap only.**

### Negative labeling is occasionally necessary

As was pointed out in the earlier article on informative labeling,[2] clarity is the prime consideration of labeling. The clearest and most forceful statement is the one to use whether it involves "never" or "not" or both of them. Other industries use the injunction "Do Not" if it is required for emphasis. In the textile field, this is quite common.

It has been held that precautionary labeling is not needed because it is the buyer's responsibility to make certain that the proper plastic or plastics have been employed in the manufacture of any product he buys. Such a viewpoint is understandable but not realistic. At present buyers simply do not know if the correct application has been made of a given plastic. And manufacturers of finished products, in many instances, either do not know the fact themselves or are not exercising the self-restraint in designing products, selecting materials, etc., which the circumstances demand. Price is too often the dominant consideration in the production of the goods.

Precautionary instructions do have a positive place in any labeling that would really do the job. It is not difficult to understand, though, why there is such a reluctance toward the use of labels that may, under some conditions, needlessly curb sales. Perhaps a compromise can be evolved. Perhaps labels could sidestep the use of negative or precautionary terms if extensive use is made of bulletins to salespersons. The forms which Kresge's have employed with such marked success indicate this to be true.

### Educational aids for salesperson and consumer

In fact, bulletins to retail salespeople are really only one of three important steps that can be taken to give support to a program calling for extensive use of informative labels. The three follow:

1. Widespread employment by manufacturers of specialized bulletins for distribution among the retail salespersons, giving them precise and positive background information about their merchandise. Keep the copy terse and to the point. Slant it to the retail salesperson's needs. Augment the information carried on the labels or tags. Include in these bulletins such negative or restrictive information as you may hesitate to use on the tag or label.

2. The development of a plastics "reference manual" which sets forth in as non-technical terms as possible all of the pertinent facts about the entire plastics scene that a buyer or

**GENERAL**

**This set is made of a tough chip-proof plastic. It is tasteless and odorless and is color fast. Wash in warm *but not boiling* water. Do not place near stove or high heat.**

**EDUCATIONAL**

**This set is made of a cellulose acetate plastic, one of many plastic materials. It is smooth, won't break easily. Color is permanent. It is free from taste or odor. Wash in warm water. Do not use in boiling water. Do not place near stove or high heat.**

**GENERAL**

**The handle of this tool is made of plastics. It is tough, shockproof and unaffected by weather. It is highly flammable. Keep away from open flame or high heat.**

**EDUCATIONAL**

**The handle of this tool is made of a cellulose nitrate plastic, one of many plastic materials. It is smooth but tough, won't shatter if dropped. It is highly flammable. Keep away from open flame or temperature in excess of 300 deg. F.**

## Merchandise Information for "Better Selling"

Item (No. & Name)_____ Retail Price____

Item size, capacity, etc._____

If a set—set consists of_____

Details of materials used in item (include grade, gage, size, etc.)_____

Details of finish_____

Construction details of interest to consumer (include design detail)_____

Uses of item_____

Proper consumer care of item_____

The outstanding selling features_____

salesperson may need to know. Keep these, too, as short as possible. Set it up in a format which makes it easy to read. Use plenty of illustrations. ("Not more than 40 minutes' reading," said one buyer in discussing such a manual for the use of his salespeople.)

3. Develop a far-flung educational program to give the public in general an understanding of plastics. This is in reality a public relations program to keep people informed on new developments as well as on both old and new products. It can be employed to combat some of the misunderstanding and confusion that have already developed.

We have included the last observation because some such effort should clearly be made over a wide front and through every available channel. Yet, it is an industry-wide matter, and how, or when . . . or whether . . . are considerations beyond the immediate scope of this discussion. We have included it here only to make as complete as we can the inventory of remedial steps which we maintain the situation demands.

Step No. 2, also, might be termed an industry-wide responsibility. It could, however, be undertaken just as readily by an alive retail trade association or industry-wide committee. Step No. 1, as well as actual informative labeling, must be lodged directly on the doorsteps of individual manufacturers, even though industry-wide efforts could be undertaken to deal with general problems.

### Precautionary labels protect manufacturer and consumer

Someone recently said that protective labeling offers protection to the industry as well as to the distributors and consumers. No doubt some basic plastic manufacturers have individually weighed the advantages and disadvantages of a protective program of control in which the end use of a plastic is subjected to review by them. Under such a plan, a manufacturer of the raw material would conduct research, would counsel molders and fabricators on the proper application of his materials, and would assist in the merchandising and promotional efforts attached to marketing the finished goods.

The concept is not new on the American business scene. The American Viscose Co., for example, has employed some such policy for many years. Its "Crown Tested" label may be used by its customers only on such rayon yardage as has been tested and approved by the company for specific purposes. One fabric may be endorsed for use in sportswear costumes, another for slipcovers, and so on. The tag supplied by American Viscose Co. states whether the fabric should be washed, hand washed or dry cleaned. It gives the yarn content of the fabric and instructions for washing or cleaning. Before use may be made of the "Crown Tested" tag, licensees must submit samples for laboratory testing. Minimum standards have been established on the tensile strength required for various purposes, on color fastness, on finish, and other such considerations which are of such vital interest to the average consumer.

A few plastics manufacturers have undertaken individual programs for protecting and promoting their trade names. Some material suppliers have helped their customers prepare labels which included trade names, descriptive materials and instructions for use. Rohm & Haas Co. actually provides such labels for their customers.

The closest approximation of the plan outlined above is the policy followed by Comprehensive Fabrics, Inc., marketing agency for Koroseal consumer items. Since 1939, this firm has insisted upon passing on advertising or printed matter involving use of their trade name. It has encouraged the inclusions of as much information as possible on labels for all products made from the material. The company's postwar plans call for even more direct control to insure that the proper material formulation is chosen to meet specific end use requirements. In other words, a tough, abrasive-resistant compound, suitable for luggage, will not be recommended for baby pants, where softness, flexibility and acid resistance are essential.

### Urgent need for realistic program

There has been much talk of labeling by top-flight personalities in the plastics industry.[3] It would seem as though the time had come for action. Someone, somewhere, should issue a rallying cry and begin work on an all-embracing program for dealing with the facts. Otherwise, you may hear more buyers say what we heard one of them say: "Plastics should be used for decorative accessories but not for practical, utilitarian items that have to stand hard wear." Let us not forget that informative labeling will, in itself, tend to act as a curb on such wayward producers as would make unsound use of plastics.

It would be misleading, however, to create the impression here that, by and large, plastics today stand in bad repute among retail buyers or, for that matter, among the public at large. Generally speaking, plastics loom up as miracle products, the synthetic concoctions of a chemical age, born in a rarefied stratum, but not to be understood any more than the Einstein theory is. It's wonderful, they say, but they really know very little about it. However, they are curious about its properties and anxious to learn just what can and cannot be done with these materials.

[3] The Society of the Plastics Industry in cooperation with the Plastics Materials Manufacturers Association, is preparing a report suggesting labels which might be used by manufacturers.

# Transparency in the home

STEP into the so-called "Dream Suite" which is not a dream at all but a compact bedroom, dressing room, bath unit assembly wherein plastics are used only where good engineering and good design dictate. This full scale exhibit, built by Rohm & Haas Co., was designed to show how plastics in home furnishings and fittings can be at once functional and attractive—without either quality seeming to be superimposed upon the other as an afterthought. Plexiglas is the only plastic used throughout this mock-up except for the bedroom curtains, spread and pillow covers which are of Koroseal and the Tego bonded plywood closet doors and dresser fronts.

To tour through this suite is to experience pleased surprise and genuine satisfaction. Many novel applications have been found for acrylic resin: and many old ones have been redesigned to take fullest advantage of this transparent material. But as often, plastics are rejected in favor of other materials when conditions of use seem to make such construction advisable. All this you can see for yourself as we move through this lifesized suite on a picture tour.

## An air-conditioned bedroom

*Transparent walls*—Most homeowners have longed for an air-conditioning unit, particularly for the bedroom. Yet too many have refrained from positive action in the belief that such equipment would be overly costly, both to install and maintain. An unusual solution to the problem is this exhibition bedroom which is held to a size that permits the efficient operation of a small air-conditioner for a cost approximating that of a home refrigerator.

To offset the closed-in feeling that might come should solid walls enclose such a small room and to give the impression of almost limitless space, gracefully curved transparent sheets of acrylic are used as the front and half of the side partition. As can be seen, this space-giving wall sweeps around to the doorway, also of acrylic sheet, which opens without noise or effort by sliding back into the other wall.

*Three-dimensional murals*—An equally unusual feature of this sleeping room is the mural that arches over the head of the bed. In the exhibition room the scene is one of lighted skyscrapers reaching up into the darkened night, but the design might just as well have depicted a green forest, a surrealist's nightmare or a child's dream.

The three-dimension effect and the startling lighting achieved in this mural are produced by engraving or painting individual elements of a design on separate pieces of acrylic, each the size of the finished mural. In the mural pictured on this page, four sheets were employed. The top layer was painted with the nearer buildings, the next sheet with those a bit farther away while the last or bottom piece was entirely covered with a solid background color. During construction of these murals each sheet was first painted, then assembled with all the rest. Small air spaces separate the various layers.

Before insertion into position in the wall a mural is provided with edge-lighting from a concealed light source. This light causes the etched or painted portions of the acrylic sheets to glow and sparkle, producing a mural that is truly "painted

***1**—In the bedroom, dressing room, bathroom assembly, the sleeping room was purposely made small so that it could be air conditioned at a cost no greater that that involved in the operation of a household refrigerator. To give the impression of space to this small room, sheets of acrylic resin were used for the front and part of the side walls, and for the door*

KODACHROMES AND OTHER PHOTOS, COURTESY ROHM & HAAS CO.

*2—Beauty and utility are combined in the acrylic applications that are a part of the model bath. The basin is blown from acrylic sheet, then painted white on the back; prismic bars shield the toilet from the rest of the room; and two sheets of the same material form the door of the shower*

in light." Since each of the four sheets can be lighted with a different color, it is possible to create a four-color as well as a three-dimensional effect.

*Curtain rods*—Small by comparison with the mural but equally well designed for the role it must play is the clear flat strip of acrylic which acts as a curtain rod for the multi-stripped polyvinyl chloride curtains in the bedroom. More important than the ease of installation is the way these pieces can be wiped clean with a damp cloth. And, unlike the usual metal rod, this flat strip of transparent plastic sheet blends into the walls and drapes, and does not need to be painted.

*Door knobs*—The knob of the bedroom door is a good example of the ingenious manner in which color has been made to work with transparent acrylic materials. To get a colorful, workable unit, a hole was bored in a clear acrylic knob, then color poured into the space in the center. Another piece of this same plastic, pierced by a bolt, was next cemented to the knob, acting as throat to attach the knob to the door.

## The dressing room

*Hats and shoes*—As in the entire bedroom, dressing room, bath assembly, not an inch of space is wasted in the attractive dressing room pictured in full color in Fig. 3. Even the projecting corner just outside the bedroom door has been put to use as a hat and shoe closet. Double doors swing wide to reveal (Fig. 5) a lazy susan hat rack at the top and three tiers of transparent acrylic shoe shelves at the bottom. About 12 hats can be accommodated on this revolving rack which is formed entirely of acrylic bars. Each of the upward curving arms terminates in a many-armed knob which prevents the hats from slipping out of position.

Now that fashion calls for the matching of hats and shoes it is a simple matter to spin the hat rack, bringing forward first one hat and then another, and study the effect of various hats in relation to particular shoes in the rows immediately below. With such an arrangement there is no sightless grabbing into the recesses of dark closets for the wanted shoes and no frantic opening and closing of hat boxes in an effort to determine which head gear would best suit the time and the occasion.

*Clothes closet*—Next in line on the way to the dressing table is the double closet which provides space for full length evening gowns, street length dresses, suits and men's coats, trousers and tails. Drawers, built in above the clothes rack and on the floor, add considerably to the storage space in this unit assembly.

Acrylic handles on the drawers in this double closet serve a second purpose—that of label holders. Slips of paper printed with the contents of particular drawers can be slipped under the transparent handles which are in the form of a scroll. The acrylic acts as a magnifying glass. Consequently, the labels can easily be read even from a considerable distance—or by a somewhat nearsighted person.

*Radiant walls*—Both the decoration and the illumination of the dressing room come from its walls. To make the walls serve this double purpose, they are covered with a sheet of Plexiglas which has been engraved and painted with a design—in the case of this exhibition room, a colorful and bold chestnut leaf pattern. Hidden fluorescent lamps edge-light the wall, causing it to glow radiantly wherever the paint or engraving has interrupted the smooth polish of the normal acrylic surface. The theory behind this effect is like that of the bedroom mural, only in this instance one sheet of acrylic is used instead of four. This wall follows the curves of the wall contour of both the dressing room and bath, and provides general illumination for both rooms.

This is a somewhat new concept in room lighting comparable to the "warm wall" idea of room heating—the light spreading out evenly from the entire wall instead of intensly from a fixture. In both the radiant wall and the mural painted in light, a different design is seen by reflected light than is evident when the acrylic sheets are lit up by radiant light given off by fluorescent lamps set along the edges of the sheets.

*Dressing table drawers and shelves*—Seemingly, special provision has been made for every one of the bottles, jars, small articles of clothing and for the odds and ends which usually hide themselves away as soon as they are needed. Within easy reach is the perfume niche whose circular shelves will hold a myriad of dainty perfume bottles. Illumination is provided by the radiant wall which also forms the background of this tier of shelves.

One side of the dressing table swings open to reveal a set

of removable transparent acrylic trays for cosmetics, hose and a million other small articles. These trays are formed with deep sides and rounded corners which combine to make them safe and easy to clean (Fig. 6).

And on the other side are three deep drawers which are designed to hold lingerie or other articles of apparel. These drawers are equipped with blown acrylic liners which can be quickly and easily removed for cleaning. After these liners were formed, they were sprayed on the back with a pale pink paint to make them opaque.

*The puff*—Like a band-box is the huge dressing table chair. This transparent drum is formed from sheets of acrylic resin and is topped with a tufted cushion covered with polyvinyl chloride fabric. With room enough for two, it does away with odd chairs that are always getting in the way in most bedrooms and dressing rooms. And it also adds a strange lightness and sparkle which complements the airiness of the rest of the compact three-room unit.

## The reflection corner and bath

Moving on to the bath, what might otherwise be waste space is again put to good use as it was for the revolving hat rack and the shoe stands. Here a protruding corner is turned into a drying rack. Three bent acrylic rods are affixed to the door of this cabinet which is designed to be heated and ventilated with a unit that cuts drying time to a minimum.

*Sink and medicine cabinet*—And just beyond this drier is the over-size wash basin where baby can be given a bath or where small articles of clothing can be washed with ease. Like the drawer liners, this basin was deep drawn from clear acrylic sheet, then sprayed on the back with white paint.

The faucet handles are fabricated from heavy chunks of this same transparent plastic to a shape which is easy and comfortable to grip. They are cut in such a way that the clear plastic catches and reflects the light almost like a gem.

There is double space in the medicine cabinet due to the fact that acrylic shelves are attached to the back of the mirrored door, supplementing those usually found in such cabinets. To prevent the small bottles for which these shelves are designed from falling into the basin whenever the door is opened, each of these four shelves has an inch-high lip at the front.

The fear of mistakenly picking up a bottle of poison instead of some innocent medication seems to be universal. Recognizing this fact, the designers of this three-room suite have set aside one entire shelf in the medicine cabinet for poison. To make doubly sure that no mistake can be made, this shelf is covered with a downward swinging sheet of red acrylic resin upon which the word "POISON" is painted in white letters.

And to top off the wash basin and medicine chest is the commuter's clock whose acrylic dial is lighted by fluorescent tubes set on either side of the mirror that covers the cabinet door. As with the fluorescent tubes around the dressing table mirror, these lamps also light the radiant walls.

*Prismatic screen and storage shelves*—The toilet, whose smooth functional lines mean easy cleaning, is shielded from the remainder of the bath by a row of acrylic resin bars cut in the shape of prisms. Because of the reflections thrown from the surfaces of these prismic bars, the acrylic appears to be opaque—providing privacy for the toilet area.

Just beyond, halfway between the wash basin and the shower stall, are the towel shelves and racks, and the concealed hamper. Again transparent acrylic resin sheets and rods are used to good account for the bars, shelves and supporting rods (Fig. 4).

*The shower*—Immediately adjacent is the shower which is equipped with automatic temperature controls both outside and in. Anyone who has tried to regulate the flow of water in a shower without either freezing or scalding himself will appreciate the convenience of this dual system of regulating the temperature of the water.

The shower control knobs are much like the knobs on the bedroom door and on the various dressing table and wash basin compartments. As with these other handles, the shower knobs had a hole drilled in the center into which color was poured. The method of attachment, by means of an extra piece of acrylic, is also the same. But, when these water control knobs are viewed from the side they appear to be clear except for a single line of color and when viewed head on they seem to be completely colored, the light diffusing the coloring throughout the handle. In this they differ from the previously described door handle which never shows quite so little nor so much color.

(*Please turn to next page*)

**3**—*The base of the dressing table stool, the knobs and drawer liners all are formed from acrylic. Perhaps the most startling use of this material is in the walls which consist of engraved or painted sheets of acrylic*

5

4

6

*4—This close-up of the shower shows how acrylic bars and sheets have been put to good account in this life-sized model three-room assembly as towel racks and shelves, shower control panels and shower doors.* **5**—*Both the lazy-susan hat rack and the three-tiered shoe stand are formed from acrylic resin.* **6**—*One side of the dressing table is given over to deep acrylic cosmetic shelves*

The space-giving effect that can be achieved so well through the use of large sheets of acrylic resin is again put to test in the shower stall. One half of the wall of this shower consists of two pieces of curved Plexiglas, one of which slides back of the other to permit entrance to and exit from the stall. In this exhibition unit the transparent wall of this circular shower is etched with only the faintest design. However, should greater privacy be desired, the pattern could be so heavy as almost to make the sheets opaque. Just as with the rest of the illumination in this exhibit, the lighting for the shower comes from fluorescent tubes set into the wall on either side of the transparent enclosure.

To achieve a color effect in the transparent doors of the shower stall, the edges of the acrylic sheet nearest the fluorescent tubes are colored. Thus, when the light strikes the painted edges, color is diffused through the entire surface of the transparent plastic doors which enclose the shower.

The clever substitute for a door knob is clearly evident in Fig. 4. In one half of the acrylic shower stall door a smooth hole has been cut which is just the size to be gripped easily. In the other half—the stationary part—a square-cornered U section has been cut away. This permits a complete opening of the movable half of the two-part door.

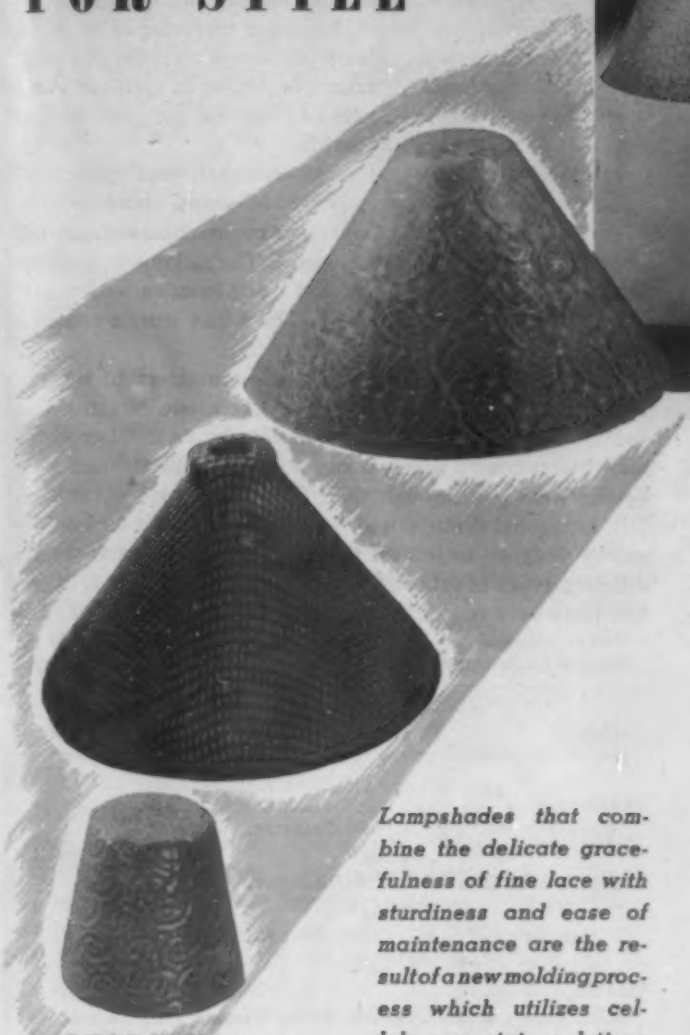
Another thoughtful application of acrylics in this section of the model 3-room suite is a handrail that runs around the solid wall of the shower. A bather need have no fear of slipping and falling when such a firm support is so close at hand. And the soap is well taken care of in this unit assembly. A deep dish has been supplied, set well back in a recess of the wall so it will be protected from the water when not in use.

The usual shower nozzle has been split up in this model stall. A number of sprays are set into the walls so that water will flow from all sides. And they are set at a height which will make shower caps unnecessary.

### A starting-off place

Many novel uses have been suggested for plastics in this life-sized bedroom, dressing room, bath assembly—but as many more will probably occur to the reader of this picture tour as he scrutinizes the three four-color and the three black and white illustrations. The way has been shown, however, in which beauty can be combined with practicality—with no sacrifice of either of these essential qualities.

# MOLDING FOR STYLE



*Lampshades that combine the delicate gracefulness of fine lace with sturdiness and ease of maintenance are the result of a new molding process which utilizes cellulose acetate solutions*

DELICATE lace, sturdy burlap, gay chintzes, are equally effective in new lampshades designed by Joseph Mrazek and made possible through the utilization of Hercules cellulose acetate liquid plastics.

Taking his cue from the radar housings which his firm has been molding since the outbreak of war for aircraft purposes, this manufacturer has developed a distinctive type of *molded* lampshade, strong, lightweight, easy to keep clean, and offering an opportunity for excursions into design fields hitherto strictly limited for lampshades because of previous methods of manufacture.

Molds employed are inexpensive; experimental models were made on aluminum dies but plaster, plastics or wood may be used.

The fabric is thoroughly saturated in the cellulose acetate solution combined with certain plasticizers and solvents. The solvents have a stretching effect on the cloth fibers so that when the fabric is placed on the mold it is easily worked and no gathers appear. The cloth is easily hand-worked over the mold for a snug fit.

When a fine lace is used, too transparent to serve as a shade by itself, another cloth serves as a lining, being soaked in the liquid mixtures and smoothed on the mold. The lace is also saturated with the cellulose acetate solution and placed over the lining.

The experimental models have been left to air dry, and take from 10 to 15 hours. However, quick drying in a special room would be used in mass production, reducing drying time to 3 to 4 hours. It is estimated that in production, cutting the cloth and performing the various molding steps should take about 15 minutes.

There should be a large time saving in the new process over that of conventional custom-shade making wherein the frame must be wrapped in thin binding tape, sewn both to lining and outside covering with the seam hidden by braid or ribbon which in turn is finely stitched to the shade. In addition, the cover panels sewn to the lining over the frame, must match the rest of the shade in design.

The plastic impregnated fabric shade is fully strong enough without a frame and thus avoids both the expense and work of framemaking as well as eliminating the steps in fitting shade to frame. The consumer benefits from the absence of framewires, which, in cheap or delicate shades, easily fall out. If, however, exceptionally thin lace covering is used, a supporting circular wire at top and bottom can be easily bound in with the same resinous liquid.

The plastic material will not shrink in moist weather as does some parchment or vellum, nor will it break as does mica or glass if knocked to the floor. Its glow, modified by the fabric, is softer than most glass or mica shades. In fact, the solvents in the material appear to bring out the colors in a chintz shade and serve to enhance the pattern of the weave of most fabrics employed.

Cleaned with a damp rag, it appears that these lamps would be practical in the sootiest city, receiving the roughest treatment even when materials, such as fragile lace or net, or pastel colors, are used.

The shades are molded at present of various materials chosen to complement distinctively designed bases by Rena Rosenthal. For example, white lace shades are molded for crystal, styrene or acrylic bases; jute or hemp for wood and pottery; cretonne for porcelain. Such combinations merely suggest, however, the future possibilities which are latent in this new method of making lampshades. When mass production of this item is finally a reality, other interesting and unusual developments can be expected.

# Plastic versus glass bottles

WHAT is the comparative resistance of blown thermoplastic and glass bottles to shipping hazards? Some light is shed on this question by a series of tests made possible by the cooperation of The Plax Corp., manufacturer of blown plastic bottles; Grand-City Container Corp. and Robert Gair Co., container manufacturers; and the Container Testing Laboratories, an independent testing laboratory.

According to reports from these tests, acetate bottles showed the greatest endurance, surviving five drum tests, each of which involved 150 falls, without visible damage. Butyrate bottles stood up almost as well withstanding 150 falls in all but the second test. In the case of the polystyrene bottles, performance varied, breakage occurring after 36 to 104 falls. The glass containers performed according to long-established standards—breakage occurring in each test after about 46 to 69 falls. Results of each test are presented in the table at the end of this article.

Shipping containers for glass packages, and glass containers themselves, have been tested many times so that requirements are well known to the common carriers as well as to shippers and manufacturers. The unknown quantity at present is the ability of bottles made from various plastic formulations to withstand the handling they can be expected to encounter in shipment.

Rather than subject the packages containers to the uncontrolled test of actual shipment, where one carton might well be given extremely rough handling while another would make the trip with hardly a knock, both the plastic and glass bottles were put through their paces in the laboratory. A 7-ft. hexagonal drum, studded on the inside with various obstacles designed to subject the test package to a great many different types of falls, was used for this work. In all cases, five tests were run on each type of blown container. If no

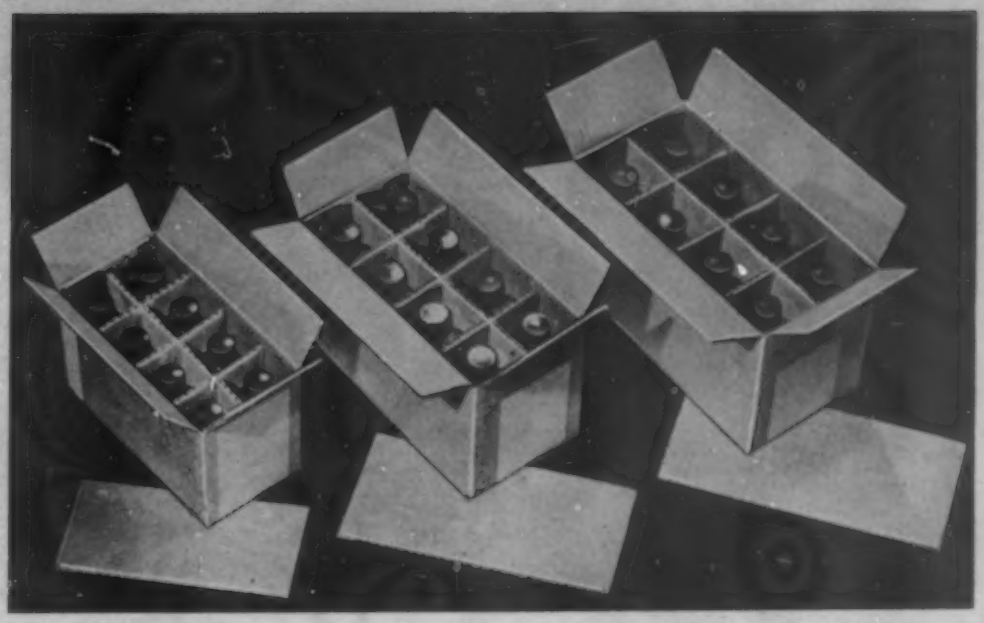
1

TABLE I—SPECIFICATIONS OF PLASTIC AND GLASS BOTTLES

| *Material* | *Dimensions* | *Capacity* | *Weight of 8 empty* |
|---|---|---|---|
| | | *cc.* | *gr.* |
| PLASTICS | | | |
| Acetate | 2 1/4 in. outside diameter, 5 7/16 in. high | 233 | 287.2 |
| Butyrate | 2 1/4 in. outside diameter, 5 7/16 in. high | 233 | 287.2 |
| Polystyrene | 1 15/16 in. outside diameter, 4 1/2 in. high | 126 | 225.6 |
| GLASS | | | |
| Flint glass | 2 3/8 in. outside diameter, 5 11/16 in. high | 239 | 1252.0 |
| Flint glass | 1 15/16 in. outside diameter, 4 1/2 in. high | 113 | 818.8 |

2

***1—This 7-ft. hexagonal testing drum is studded on the inside with obstacles which subject the packages under test to many different types of falls. 2—From left to right the 5 types of test bottles are: red acetate, amber butyrate, clear polystyrene and two of flint glass***



3—*Three sizes of light-weight containers were used for these tests. The box at the left was used for the small glass bottles and the polystyrene containers; the one in the middle for the acetate and butyrate bottles; and the box on the right for the large glass bottles*

breakage occurred after 150 falls the test was discontinued. In the event a bottle broke it was replaced with a fresh one; thus many of the bottles survived as many as 750 falls.

Plastic bottles of three different formulations were obtained for use in this break test. For purposes of comparison, glass bottles were obtained that matched as closely as possible the size and capacity specifications of the plastic bottles. The specifications—dimension, capacity and weight—of both the blown thermoplastic and glass bottles are presented in Table I.

All the bottles were fitted with standard type plastic closures and the dimensions include the closure.

So that a maximum of outer surface would be presented to receive the action of the shocks resulting from the drum tests, eight of each type of bottle were packed one high in two rows of four each. Boxes of two types were provided made specially for these tests with partitions for interior protection. Some of the containers were made with extension edges on the interior partitions, a construction which would be unquestioned by the carriers. However, a preliminary test run demonstrated that such a packing was stronger than would ever be required. In the subsequent tests, boxes of the regular slotted carton style of construction were used, made of B Flute 125-lb. test corrugated with non-test A Flute partitions and top and bottom pads. The loaded boxes were sealed with 3-in. kraft paper tape. All were conditioned for 24 hr. at 65 percent R.H. at 70 deg. F. before the tests were run.

For purposes of the test, the larger size glass bottles and the two larger sizes of plastic bottles—the acetate and butyrate bottles—were filled with lubricating oil approximately S.A.E. 15. The smaller size polystyrene bottles and the glass bottles of approximately the same size were filled with 25 percent solution of alcohol.

It should be pointed out that the containers used in these tests would not have been accepted by the carriers for rail shipment. These boxes were used, as explained earlier, to cut down the time of the test. However, since both the plastic and glass bottles were packed in identical boxes, a definite comparison can be made between the test results (Table III).

TABLE II—WEIGHT OF FILLED BOTTLES

| *Material* | *Weight single bottle (filled)* | *Weight 8 bottles (filled)* | *Gross weight 8 bottles and container* |
|---|---|---|---|
| PLASTIC | | | |
| Acetate | 36 gr. | 288 gr. | 4 lb. 11 oz. |
| Butyrate | 36 gr. | 288 gr. | 4 lb. 12 oz. |
| Polystyrene | 28 gr. | 224 gr. | 3 lb. 1 oz. |
| GLASS | | | |
| Glass, large | 157 gr. | 1256 gr. | 6 lb. 14 oz. |
| Glass, small | 102 gr. | 816 gr. | 4 lb. 2 oz. |

TABLE III—RESISTANCE OF BOTTLES TO SHIPPING HAZARDS

| *Test run* | *No. of falls to breakage* | *Result of test* |
|---|---|---|
| ACETATE (LARGE PLASTIC BOTTLE) | | |
| 1st | 150 | No breakages |
| 2nd | 150 | No breakages |
| 3rd | 150 | No breakages |
| 4th | 150 | No breakages |
| 5th | 150 | No breakages |
| BUTYRATE (LARGE PLASTIC BOTTLE) | | |
| 1st | 150 | No breakages |
| 2nd | 51 | One corner bottle broken |
| 3rd | 150 | No breakages |
| 4th | 150 | No breakages |
| 5th | 150 | No breakages |
| POLYSTYRENE (SMALL PLASTIC BOTTLE) | | |
| 1st | 87 | Two diagonally opposite corner bottles broken |
| 2nd | 49 | One corner bottle broken |
| 3rd | 104 | Two diagonally opposite corner bottles broken |
| 4th | 36 | One next-to-corner bottle broken |
| 5th | 58 | One corner bottle broken |
| GLASS BOTTLE (LARGE) | | |
| 1st | 53 | One corner bottle broken |
| 2nd | 46 | One corner bottle broken |
| 3rd | 40 | One corner bottle broken |
| 4th | 44 | One corner bottle broken |
| 5th | 45 | One corner bottle broken |
| GLASS BOTTLE (SMALL) | | |
| 1st | 143 | One corner bottle broken |
| 2nd | 46 | One next to corner bottle broken |
| 3rd | 63 | One next to corner bottle broken |
| 4th | 31 | One corner bottle broken |
| 5th | 64 | One next to corner bottle broken |

# Plastics in Review

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**1** Soap is kept high and dry in a holder of Tenite II which has drain holes to allow the water to run off. Plastic Molded Arts Co. molds the soap dish by the injection method for Charles Parker Company. Ridges raise the soap slightly above the bottom of the dish so that slippery fingers can get under it far enough for a firm grasp

**2** Each time a shad spawns it fasts, producing an age-scar on its scales. By recording thousands of scales on translucent Celluloid or Nitron plates, the Fish and Wildlife Service of the U. S. Department of the Interior is able to make a microscopic study of these scars for their work in restoring depleted shad fisheries of the Atlantic Coast. A faithful reproduction of the fish scales is made by placing them face down on the plastic sheet and applying carefully regulated heat and pressure. The resulting impression is easier to read than the scale itself and the slide does not deteriorate like those made of other materials which were used when the project was first started

**3** A bisectional device that grates the vegetables but is easy on the nerves, to say nothing of the housewife's hands, makes a welcome addition to the kitchen. The utensil is injection molded of Lumarith and is equipped with both a rough surface for grating and sharp-edged aperatures for shredding. Especially endearing to the owner is its rustproof quality. Although this item is produced by a number of companies, the grater pictured is molded by Caldwell Products, Inc.

**4** A flip of the finger opens the transparent cigarette case which B W Molded Plastics, also the distributor, injection molds of thermoplastic material. The case holds a full pack of cigarettes

and keeps them from being crushed and spilling tobacco dust in the purse or the pocket

**5** The two-faced Swivelette mirror leads a double life as a shaving or make-up mirror and is easily turned to show either its clear or magnifying side. The frame and base are fabricated of Lucite or Plexiglas by Revell Plastics, division of Precision Specialties, which is also the manufacturer

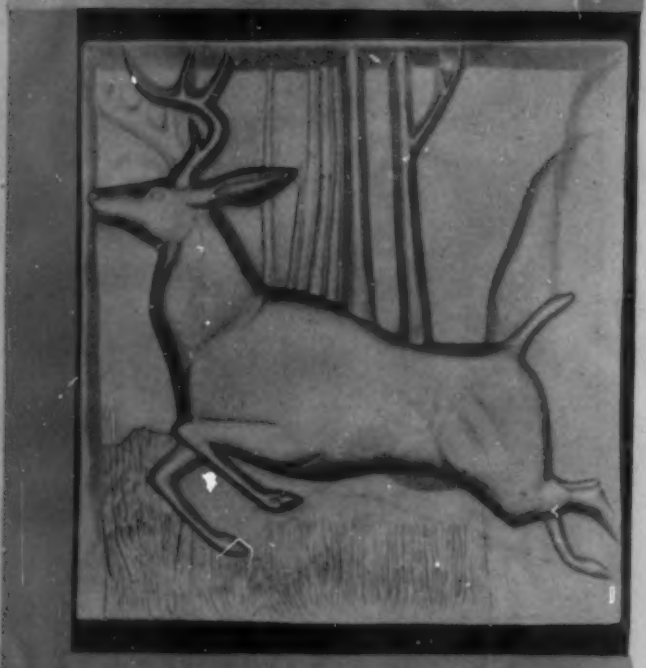
**6** Treasure in the form of gold nuggets, gold powder, magnesium crystals or fern leaves is locked within the Plexiglas walls of these unusual pendants. The gold or greenery is laminated between two pieces of acrylic which are shaped at the same time by a special process that eliminates seams. When gold powder is used the two halves are formed ahead of time to provide the round cavity for the powder. The lockets are made by Paramount Plastics Co.; the gold nugget lockets for Alaska Wholesale Co. and the others for California Accessories

**7** Shining braided belts of Plexon fashioned for sports or dress wear by Vogue Belts, Inc., are a bright idea for a dull dress. Lightweight and washable, the belts come in a large number of styles and colors, including a solid color tie front model and a sports model with contrasting blue harness buckle. Suggested applications for the braided plastic material include a line of handbags, quick change purses and similar accessories

**8** Electrical instruments can be more safely attached to panel boards with cap screws and nuts of black Tenite which, having high dielectric strength, provide good insulation. Injection molded by S. S. White Plastics Division, New York, N. Y., the small parts withstand hard use and can be assembled tightly without breaking. Proper fit between nut and screw is assured by holding the plastic to close tolerances in the molding

**9** A cigarette lighter to capture the fancy is fabricated by R. E. C. Sales Co. of alternating layers of colored and clear Lucite combined in such a way that from different angles the lighter appears variously banded with color or tinted solidly throughout. Individual blocks of the methyl methacrylate are dyed, then laminated together and finished by sanding and buffing. As the final step the lighter mechanism is inserted in the hole drilled for that purpose

**10** A fishing kit fits the bill when dinnertime rolls round on a life raft. Navy fliers carry a compact kit of Lumarith, injection molded by Bachmann Bros., Inc., for Edw. K. Tryon Company. This provides them with a good selection of tackle for catching both fresh and salt water fish, plus a burning glass with which a fire may be started. Instructions appearing on the case are simple but complete enough to help even the greenhorn to become a good fisherman



OVER ONE THOUSAND PLAQUES, SIMILAR IN style to the one illustrated here, are being produced monthly by R. A. Gunter. These reproductions, which are made from the famous Burnham collection of woodcarvings, are specially plated to give them the semblance of the originals.

Good appearance and low cost are the ruling factors in most reproduction work—particularly reproductions of original woodcarvings and statuettes. Both these conditions are met in the Plastiart plaque and pen holder shown in the accompanying illustrations. This material, which combines ceramics and thermoplastics, is remarkably durable and can be 100 percent reclaimed without additives.

This material also has good safety features and can be cast in all types of molds by pouring, brushing, spraying or sloshing without consequent shrinkage or warping. Low operating temperatures and quick cooling characteristics make it possible to produce individual casts in less than 5 min. with a minimum of equipment. Best results are obtained by brushing or spraying the material into a mold with an ordinary paint brush, with the surfaces of the mold being coated as rapidly as desired. Successive coats build up the wall thickness of the mold.

Finished casts can be painted, plated or brightly polished by brisk rubbing with steel wool. Too, surface breakage can be readily repaired with new material which can be heated and worked with a soldering iron.

# PLASTICS

THE PROBLEM OF CONTROLLING DESTRUCTIVE insects in industrial units entails constant spraying with insecticides. In the steadily waged battle against these tiny enemies, an electric sprayer is a welcome ally. One such instrument, marketed as the Electro Sprayer, develops a superheated dry steam which vaporizes and activates powerful insecticides.

Manufactured by Electro Spray Corp., the streamlined sprayer, which weighs only 12 lb. when filled with insecticide and distilled water, utilizes plastics to good advantage for lightness, freedom from corrosion and resistance to extreme heat. The Gibbs Manufacturing Co. molds the plastic parts of the apparatus. The case and cover are molded of Bakelite; the mounting plate of Durite; the handle, caps, and knob of Durez.

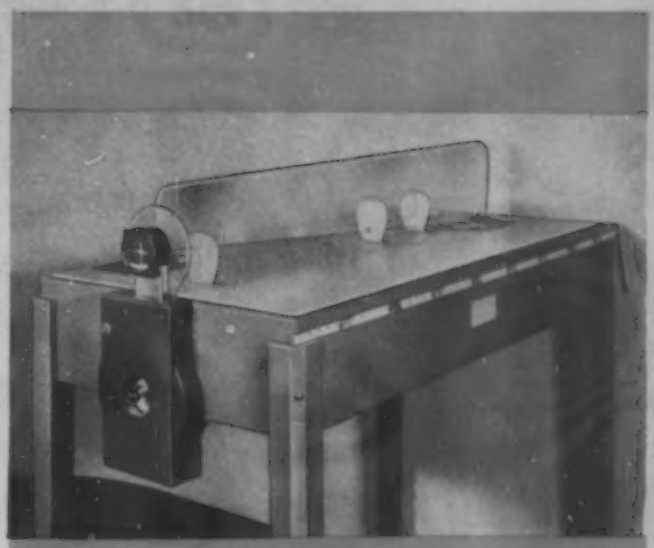
The container body is divided into three sections: a circular rear section holding the body and heating element; and two other sections holding the insecticide and the water, respectively. The dividing compartments must be drawn to the full depth of the case so that the 14 threaded inserts, used to fasten the plate and cover to the body, may be firmly anchored.

To operate the sprayer, the hand throttle is depressed. This releases water into the heated chamber where it is developed into superheated dry steam. The steam serves as a medium to diffuse and activate the insecticide.

WITH THOUSANDS OF OUR YOUNG MEN ALREADY experienced pilots and the major portion of the younger generation airminded from their first toys, training aids for such flight hazards as "shooting blind landings" still remain a highly essential part of our postwar educational program. These aids usually consist of model scale mockups of standard equipment on which students of aeronautics may readily visualize the operation of the system before going into the air.

The apparatus shown here, which was developed at the Training Aids Section, Equipment Laboratory, Air Technical Service Command, at Wright Field, consists of a table with an airport mapped out at one end. The table is divided through the center by an acrylic resin altitude panel. A black line etched against the acrylic panel represents the radio indicated glide path along which an exact scale model of the plane comes in for a landing. Three fan-shaped markers along the path flash a prearranged signal in turn as the plane passes over each—like the blinker lights on an instrument panel—to denote both the plane's elevation and its distance from a specified point on the runway. Faintly indicated radial lines on the table and on the acrylic panel mark the pattern of the radio waves which converge to create the invisible path along which the plane proceeds.

In the foreground can be seen the cross pointer indicator, corresponding to the actual instrument on the plane which denotes horizontal and vertical deviations.

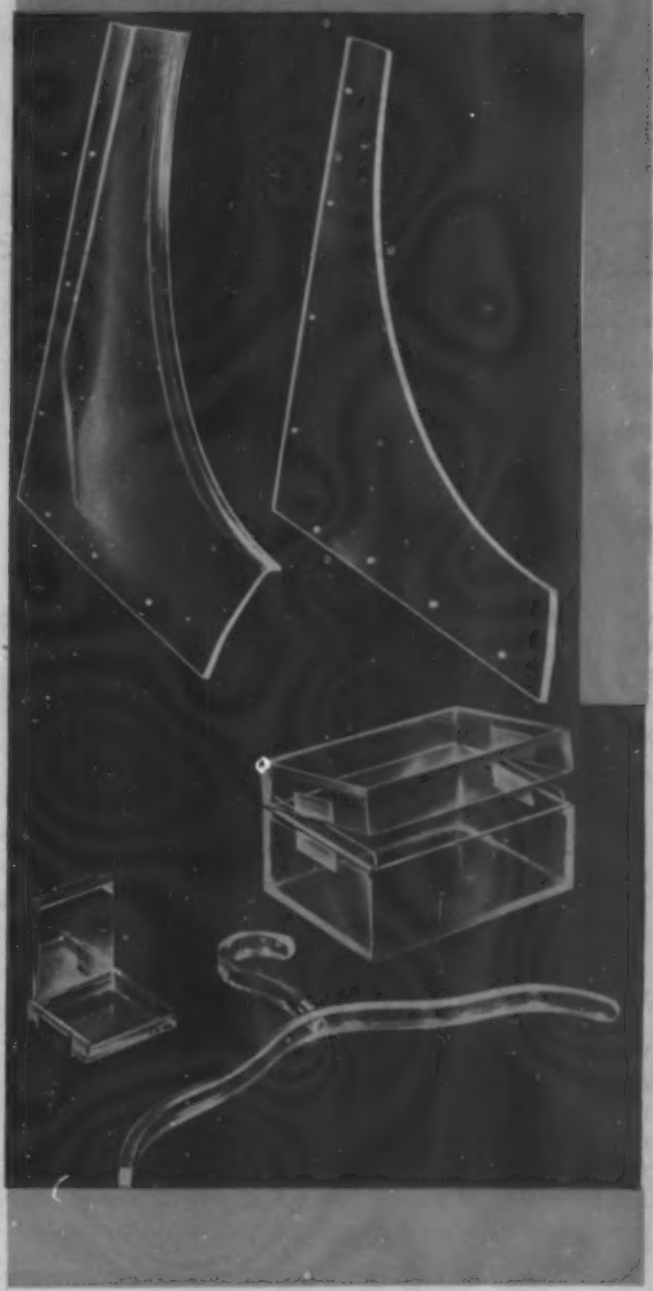


# PRODUCTS*

THE PLASTIC MEMORY OF METHYL METHACRYLATE resins is being used to good advantage in the fabrication of novelties such as clothes hangers, utility boxes and compacts. This phenomenon consists of the resin's returning to its former condition on being subjected to heat—a factor which makes possible the re-use of small discarded pieces of the material.

After deep-drawn aircraft turret domes, blisters and other enclosure parts for airplanes are cut out of the center of a transparent Lucite sheet at the plant of the fabricator and formed, there is some trim remaining in the shop consisting of corners and flanges. Instead of such "cutoffs" being discarded as waste material, the pieces are gathered together and placed in an oven where, under the application of heat, they regain their original shape and thickness even though they have been drawn out to considerably thinner dimensions. The resulting flat pieces are then cut into new forms.

For example, in the workrooms of E. L. Cournand, Inc., whose wartime output consisted of such transparent parts for airplanes as are listed above, many items of novel design are produced from the scrap. Already they have an initial output of coat hangers, utility boxes, compacts and sundry other articles of luxury interest for which an eager buying public, deprived for so long a time of the opportunity of owning anything that is so "nonessential," makes a ready-made market. Future possibilities for items of this sort seem limitless.



* Reg. U. S. Patent Office.

ALL PHOTOS COURTESY ROLLE CASTING CO.

*The box in which the sand cores are formed is "rammed" with moist sand to insure uniform packing in the mold*

*After removal from the sand core box, the sand core is inspected and any minor flaws are repaired before it is baked*

# Resin binders improve sand cores

by F. G. FELSKE*

THE casting of metals is an art where, in spite of the manifold improvements in the handling of metals, technical advances have not been able to replace the skill of the individual craftsman nor to devise any new method which will produce so economically such a variety of complicated metal forms ranging in size from less than one inch to many feet. The importance of the sand core in producing sound castings and reducing the number of defective parts cannot be overemphasized. Cracks, hot tears, blow holes, porosity, smoothness and dimensional conformance are all influenced by the quality and performance of the core, whether the metal be grey iron, bronze, aluminum or magnesium.

## Casting and sand cores

Basically, the foundry process of casting metal consists of first forming a sand mold of the exterior of the casting and then filling the cavity with the molten metal. Upon cooling, the sand around the metal is shaken away and the casting is ready for the trimming and finishing operations. Obviously, the proper dimensions of the casting will depend upon the skill with which the molds are made.

Many castings require an internal cavity surrounded by metal. An example of such a casting would be an aircraft cylinder head barrel where an internal combustion chamber must be provided. To incorporate cavities of this type in the casting, a sand core is customarily employed. This core serves to confine the molten metal during casting to the desired area and thickness. It is generally prepared with silica sand using a binder comprising a drying oil, such as linseed, cereals, resins, sulfite liquors, sodium silicate, pitch, silica flour, etc., or combinations thereof. In certain cases, the sand may be modified with metal protective agents and inhibitors such as sulfur and boric acid.

Of the primary requisites of a core sand binder, proper collapsibility is of major significance. The hot strength of the binder must be such that the core will break down at temperatures appreciably below the pouring temperatures of the metal shortly after a thin skin of metal has solidified around the core. Collapsibility of the core is essential since it permits the contraction of the metal during solidification and ready removal of the core through narrow and constricted metal sections during the cleaning and finishing of the casting.

Secondly, a core sand binder should provide good workability properties. The binder, after it has been uniformly dispersed throughout the sand, must impart "green" strength sufficient to permit the handling of the molded core on conveyors or racks before baking, without sagging or fracture. In addition, freedom from sticking in the core box sand conveyor ducts is necessary if surface irregularities are to be eliminated, and production efficiency maintained.

## The "why" of synthetic resins as binders

The limitations and deficiencies of many types of core binders in use by the foundry industry and the important requirements for these binder materials suggested the desirability of a detailed investigation of the use of synthetic resins as binders. Water-soluble resins of the urea-formaldehyde type were a logical choice for several reasons. In the first place, it was known that urea-formaldehyde resins decompose

* Resinous Products & Chemical Co.

*In the forming of resin bonded sand cores, a fast bake at a moderate temperature is a highly important quality*

*The baked core is placed within the bottom half of the mold. Here the "cope" or top mold is lowered into place*

at the pouring temperatures of aluminum and magnesium much more rapidly than drying oils. Thus, they would be expected to lose their strength characteristics once a thin skin of metal had formed around the core, permitting contraction of the metal on solidification and facilitating removal of the core through narrow constricted openings during casting clean-up. Commercial experience with urea-formaldehyde bonded cores were shown to reduce casting defects and to cut the time consumed in cleaning and finishing castings.

Secondly, since urea-formaldehyde resins cure by condensation rather than oxidation, they naturally develop their maximum binding strength in a shorter time under less drastic conditions than does a drying oil. Because air must get into the interior of the core to set a drying oil binder, baking schedules as long as 4 to 6 hr. at temperatures ranging from 375 to 500° F. are necessary when the oil is used. Urea resins, on the other hand, will cure in 30 to 90 min. at 325° F. This means a saving in fuel and an increase in oven capacity.

The low temperature baking characteristics of urea-formaldehyde resin offer a further advantage for magnesium sand cores because the protective agents are not volatilized during cure. The high temperatures required to set oil cores necessitate the use of excessive additions of these protective agents. In contrast, resin sands, with minimum inhibitor concentrations, are found to provide adequate and uniform protection for a wide range of core designs.

A third reason for the choice of urea-formaldehyde resins as binders was that these resins were known to co-react and hence, waterproof cereals of the type used for imparting green strength to core sands. The hygroscopicity of cereals when used with oil has always been a serious limitation particularly in the case of magnesium cores where moisture will cause blows. Furthermore, oil-cereal bonded cores show drastic loss in strength and hardness on exposure to high humidity. This is illustrated by the fact that oil-cereal bonded cores retain only 10 percent of their strength when exposed to 100 percent humidity overnight while resin cores retain 40 percent of their strength.

*The molten aluminum is poured through orfices, called "gates", in order to fill the mold and form the casting*

## A new synthetic resin binder

After extensive laboratory and foundry experimental studies, Uformite 580,[1] a new synthetic resin binder was developed specifically for use by the light metals industry. Although basically a urea-formaldehyde type, this synthetic binder differs from the conventional thermosetting resins of this class. Special attention was given in its development to expanding the field of usefulness for resin binders to many specialty cores heretofore limited to oil-type binders. Adapta-

[1] Manufactured by Resinous Products & Chemical Co.

TABLE I.—A COMPARISON OF UFORMITE 580 AND A TYPICAL UREA-FORMALDEHYDE RESIN[a]

| Binder | Water | No. of cores rammed before: First sign of stickiness | First break |
|---|---|---|---|
| | percent | | |
| 0.45 percent Uformite 580 | 3 | 30 | 39+ |
| 0.45 percent Uformite 580 | 3.5 | 29 | 39+ |
| 0.45 percent Uformite 580 | 4 | 40 | 40+ |
| 0.9 percent Uformite 580 | 3 | 40 | 40+ |
| 0.9 percent Uformite 580 | 3.5 | 40+ | 40+ |
| 0.45 percent urea-formaldehyde | 2.5 | .. | 15[b] |
| 0.9 percent oil binder | 2.5 | 27+ | .. |
| 0.8 percent oil binder | 2.5 | 38+ | .. |
| 0 percent | 2.5 | 10 | .. |

a Sand formulation:
Ottawa silica sand (G.F.N. No. 77).....100.0 lb.
Sulfur.....0.5 lb.
Boric acid.....0.5 lb.
Cereal.....0.83 lb.
Kerosene.....0.9 lb.
b Increasing sand adherence was noted after 2 to 3 cores had been made.

bility to present core room practice and mechanical loading equipment, and usefulness with a variety of protective agents and binder modifiers were all taken into consideration in the designing of this product.

The use of this new urea-formaldehyde type resin as a core binder requires no departure from standard core procedure. Supplied as a dust-free, water-dispersible powder, this product may be added directly to the conventional muller, kneader or paddle type mixers and uniformly dispersed throughout the sand without special precaution.

Unlike many binders, which tend to stick badly to core boxes, conveyors and blower equipment, sand mixes which use this new resin came out readily. As a result, core boxes may be used continuously without any delay in production while their interiors are cleaned. This is true even with the most intricate core design. All that is necessary to effect the release of the core from the core box is a gentle tapping or vibration. Furthermore, the core surfaces are uniformly smooth and free from loose grains of sand. An indication of the workability of Uformite 580 in comparison with a typical urea-formaldehyde resin can be seen from Table I. Stickiness was evaluated by noting the number of cores to the first break. Probably, the number of cores to the first break is the more significant test since it represents a condition of the core box where cleaning with kerosene or parting compound would be necessary. The core boxes were cleaned with parting compound before use. A standard aluminum box, dumbbell shaped, was used.

Further evidence of the good workability features of this new resin binder can be seen in the extensive usage which this resin has found on core blowing equipment. Core sands used on automatic equipment must show a high degree of flowability and must be singularly free from any tendency to stick to the blower ducts and core boxes. Although it is generally advisable to make certain minor alterations in moisture and cereal content, blower core sand formulated with this urea-formaldehyde type resin binder is very similar to that used for hand ramming.

Cores prepared with these sand mixes may be stored prior to baking for periods as long as 4 to 5 hr. without loss in tensile strength or surface hardness. Generally, the core surfaces will tend to crust over on prolonged storage in the unbaked condition. This results in an advantageous increase in rigidity, but the surface drying has no effect on the physical properties of the baked core. The surface obtained on air drying is firm and smooth rather than soft and crumbly. Therefore, they do not need to be sprayed with water prior to baking.

Since the resin binder is designed to show rapid breakdown at temperatures of 450° F. or higher, a condition essential in the production of light metal castings, baking temperatures in the range of 325 to 375° F. are recommended. The baking time in this temperature range will, of course, depend upon the size of the core, but in most cases, 30 to 90 min. will be adequate to develop maximum tensile and hardness. In the case of magnesium sand formulations, wherein boric acid is normally added as an inhibitor, lower temperatures and shorter baking times are desirable to prevent overcure of the resin.

The development of improved resin binders for core sands promises to simplify greatly the common problems in the casting of light metals. The ease of forming and the greater mechanical strength of resin-bonded sand cores permit the formation of highly involved cores and consequently the casting of complicated members without difficulty. Further, the improved collapsibility of the cores reduces the number of defective castings due to strains during solidification of the metal caused by failure of the ordinary core to decompose at elevated temperatures.

Here is just one more example of the greatly expanded uses for synthetic resins by industry, wartime advances which will be reflected in civilian products of improved quality.

*When the molten metal has solidified, the mold is opened and the rough casting is removed by the operator*

TABLE II.—COMPARISON OF TENSILE DATA ON UFORMITE 580 AND A TYPICAL OIL BINDER[a]

| Binder | Tensile strength, minutes baked at 325° F. 30 | 60 | 90 |
|---|---|---|---|
| | p.s.i. | p.s.i. | p.s.i. |
| 0.2 percent Uformite 580 | 203 | 195 | 193 |
| 0.2 percent oil[b] | 163 | 161 | 194 |
| 0.5 Uformite 580 | 312 | 296 | 297 |
| 0.5 percent oil[b] | 157 | 178 | 217 |

a Sand formulation:
Ottawa silica sand (G.F.N. No. 77).....1000 lb.
Cereal.....5 lb.
Kerosene.....3 lb.
Water.....40 lb.
Dry binder and moisture content as indicated in the table
b Baked at 400° F.

*1—Molded acrylic boxes, which have been adopted by the Armed Services for all Army and Navy decorations, should prove equally popular with jewelers and display managers. They serve the dual purpose of protecting contents while putting them on permanent display*

# Decorations on display

DECORATIONS are meant for display whether they are badges of honor, such as the Purple Heart shown in the above illustration, or sparkling jewels. Yet, too often, they are shut away from sight in conventional velvet or satin lined boxes during most of their existence.

All this will be changed when Lucite and Plexiglas boxes are adopted by jewelers just as they have been accepted by the Armed Services for all Army and Navy medals and decorations. The transparent tops of these cases put decorations on permanent display, set off by the solid blue of the bottom half.

Until a short time ago medals of both branches of the services were presented to recipients in boxes made of aluminum and imitation leather, wood and imitation leather or a combination of several other materials. Aside from the fact that these old-type containers lacked the sparkling appearance of the new plastic boxes and shut their contents from sight, they also tended to deteriorate in storage and in use.

Stock keeping was also a problem when solid faced boxes were used. If clerks were to be saved the trouble of opening each medal container to ascertain its contents when the call came for a presentation, the name of the decoration had to be stamped on the cover of the box that held it. And while this system reduced the labor of one supply section, it added to the duties of another. Once stamped, the box could not be used for a different medal. It was necessary, therefore, for the Army or Navy supply section to keep in stock as many different types of boxes as there were military decorations.

Now, thanks to the transparent acrylic top, one box serves for all medals. A glance at the case is all that is needed to ascertain the decoration it contains—and without the help of any gold lettering on the outside.

### A molded-in keyhole

There is another novel feature of these injection-molded two-piece plastic boxes. A small hole in the shape of a keyhole is molded through the solid blue bottom, approximately three quarters of the way toward the end that would be termed the top should the case be stood on its edge. This opening makes it possible for the owner of the decoration to hang the box and its contents on the wall. There it can be on permanent display, yet be protected from the deteriorating effects of dust and moisture.

It is very possible that civilans could make good use of molded acrylic containers with keyholed backs. In almost every home there are treasures which are deserving of display but are seemingly designed to collect dust in unbelievable quantities the moment they are put on view. As a result, they are either buried away in drawers or displayed until they are too faded and soiled for anything but the trash

barrel. A box with a transparent cover would be ideal for such objects.

### An idea and how it grew

It was in the fall of 1944 that the idea of a molded plastic box for military decorations reached a point where a hand-made model was ordered on the lines of a sketch designed by Aristed Ciansorani. After a few minor changes, this model was approved by the Plastic Section of the Research and Development Branch of the Quartermaster General's Office; and the Standard Plastics Co., Attleboro, Mass., makers of the model case, were authorized to build production molds for a sample lot of acrylic cases. Now, only a year after the submission of the idea to a molder, the boxes are being produced in quantity and contracts have been placed with a number of plants—the molds following the lines of those built by the original molder.

According to the specification established by the Quartermaster Corps, "The container shall consist of an injection molded, polymethyl methacrylate top and bottom, spring-closed, with a pad having attaching clips. The top of the container shall be crystal clear, the bottom an approved shade of translucent blue." The Lucite and Plexiglas used for this work have a specific gravity of 1.20 at 77/77° F. (plus or minus 10 percent). To insure the lid's closing with a snap, two Rathbun C-hinges that contain 0.70 to 0.80 percent carbon are used in each assembly. These were felt to be preferable to pin hinges not only because they would permit the transparent cover to snap open and shut, but also because they would hold the lid open without danger of its dropping closed as soon as the hand that opened it was removed.

A single mold with four cavities is used by the Standard Plastics Co. in the production of these citation or medal boxes—two crystal clear tops and two translucent blue bottoms being turned out at one time. As can be seen (Fig. 1) the lower half of the case is grooved around the outer edge on three sides so that the lid, which has a matching groove molded on its inner edge, will have a firm seat when the container is closed. Another groove is molded into the cover on its underside, running like a border around the top approximately 0.35 in. in from the edge, and one which adds much to the charm of the piece. One of the final operations on this box is the application of gold colored enamel in this groove.

The only finishing that is necessary on these acrylic parts is the removal of the gate. The halves are then ready for hinging, an operation that is performed by the molder. The gold is then painted into the groove in the lid.

### High standards a must

Before these boxes are shipped to the military services they are subjected to a number of rigorous tests. From each shipment lot of 500 containers or less, 6 samples are picked at random and put through a hinge test, a salt test on the hinge springs only, and a service test. Three additional samples are picked for use in the weatherometer test.

In the hinge test the lid is opened 2 in. and forced $^1/_2$ in. to the left and to the right at the end opposite the hinged end. After such treatment the top must remain attached to the container bottom by both spring hinges and return to a normal position when released. In the accelerated service test, after the parts are subjected to both the dry and wet procedures they are placed bottom side down on a surface plate and tested for warpage with thickness feelers. A right-angled straight edge is also employed to determine alignment of the sides of the box. Any deviation from the original alignment in excess of $^1/_{32}$ in. shall be cause for rejection.

### Now that the war is over

Soon these acrylic boxes should be making their appearance in windows as display cases and jewelery boxes. They possess the double advantage of protecting the contents from dust, moisture and other harmful forces while allowing them to be constantly on view.

Much of the credit for this development which promises to be so useful in civilian life, should go to A. E. DuBois, Heraldic Section, Research and Development Branch, Quartermaster General's Office, and to Robert E. Wilson and Major Hobson of the Plastic Section of this same branch.

**2** *and* **3**—*Military medal boxes are molded in two parts. The clear acrylic top is finished off with a handpainted gold border. The bottom of the case is solid blue and has a key-hole opening which makes it possible for the box to be hung on the wall*

PHOTOS, COURTESY MONSANTO CHEMICAL CO.

***Covered with a rust-red vinyl butyral coated upholstery, hotel serving pantry doors and dining chairs face a color-bright and mar-proof future***

EYE appeal is almost as important to the popularity of a restaurant as is the quality of the food which it serves on its tables. Farseeing proprietors, aware of the necessity of appealing to the aesthetic sense of their customers as well as to the satisfaction of their appetites, therefore tend to invest the major portion of their initial outlay in elaborately furnished dining halls. However, the wear and tear of constant use, the possible carelessness of an occasional diner, or again the steady scuffiing of serving-pantry doors by tray-laden waitresses, often produce shabby spots or marked discolorations on the room furnishings.

Since real leathers and fine woods are almost prohibitively expensive, manufacturers of dining-room equipment are always on the alert for materials which will serve to give the same effect of elegance without unduly overtaxing the already strained resources of the restaurant owner. In the past, various substitutes were employed, but a lack of flexibility and a tendency to crack and spot as well as to lose color with constant exposure to light, made many of them a poor replacement for the genuine article. The Monsanto Chemical Company, however, has come to the manufacturer's aid with a vinyl butyral coated upholstery covering which is not only attractive both in appearance and color, but is permanently flexible and non-cracking.

Employed for the first time in the dining room of the Sheraton Hotel at Springfield, Mass., this material adds appreciably to the appearance of the room. Seats and benches, covered with the rust-red upholstery coating, line the walls of the dining hall. Since it will hold its original color permanently, the restaurant proprietor need have no fear of letting the strong sunlight pour into the room. Fear of deterioration through constant use is also eased by the knowledge that the vinyl butyral coating is spill-proof, stain-proof and virtually scuff-proof. This latter quality makes it especially advantageous for the outer lining of pantry service doors which must withstand the most steady abuse.

The hotel has also taken advantage of the adaptability of this upholstery coating by embossing its furnishings with a unique geometrical design impressed on the surface. Users need not limit themselves, however, to this design, but can employ whatever pattern lends itself most effectively to the decorative scheme planned for the remainder of the room.

Vinyl butyral coated fabrics of this type are produced on equipment which is identical to that used with natural rubber and under similar processing conditions. Like rubber, too, vinyl butyral can be formulated to have a thermosetting reaction analogous to the vulcanization of rubber, providing high heat resistance and freedom from heat distortion. Other characteristics of the material include adaptability to thin, extremely pliable coatings on sheer base fabrics and ability to be formulated into a complete range of color, including clear transparent.

Although widely used as an interlayer on safety glass since 1938 vinyl butyral was developed as a coating material during the war period. Experience has demonstrated its advantages as a coating material for a wide range of applications.

# A building block for lighting

1

PHOTOS AND DRAWINGS, COURTESY LUMITILE, DIV. OF BURTON-RODGERS, INC.

*1—Extremely lightweight panels of square polystyrene tiles diffuse tube illumination for daylight brilliance throughout the interior of a large office*

*2—Tube lighting installations for lobbies and hallways can be set at the most advantageous lighting angles with the aid of these molded polystyrene tiles*

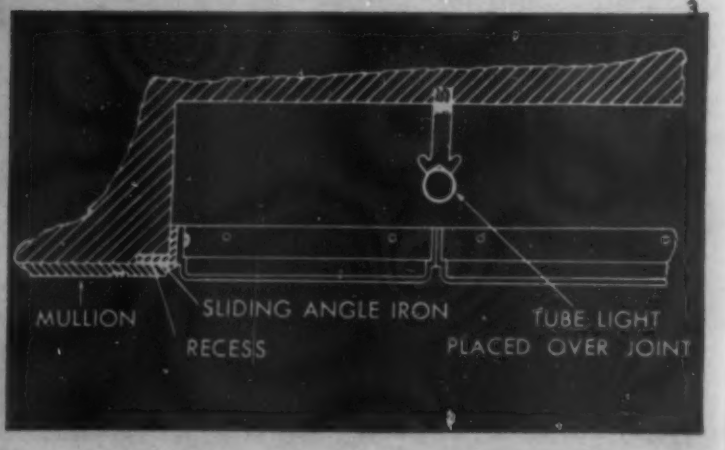
*3—Sectional view of the procedure followed in placing the molded tiles over lighting tubes. The latter must always be set directly over alternate joints*

2

TUBE lighting has grown in the last decade to be one of the most important lighting mediums; low surface brilliance, low operating temperatures, continuous lengths and adaptability made it immediately acceptable to commercial users. Millions of feet of such tubing have been installed yearly in factories, offices and public buildings, yet comparatively little has found its way into the home or into buildings where appearance is the important factor.

In 1941 tiles molded of Lustron—reminiscent of square pans or trays in appearance—were developed by Lumitile, Division of Burton-Rodgers, Inc., in order to help in meeting a need for tube lighting shields which were both attractive and practical. Perhaps the greatest advantage of these tiles is the freedom they allow in the placement of light tubes. The usual tube installations were groupings of three to four tubes supported at each end by a bracket and attached directly to

3



the ceiling, or suspended in the form of a fixture 3 to 4 ft. long by approximately a foot wide. This system concentrated the light areas close to the fixture and by so doing tended to destroy the low surface brilliance of tube lighting.

These square plastic shields allow tubes to be installed as much as a foot apart when the light source is 2 or 3 in. above the tile, and even farther apart when the tubes are 18 in. above the shields. The result is an attractive and efficient installation, yet one with a much reduced surface brilliance.

Molded of polystyrene, these 6-in. square lighting shields are amazingly light, weighing approximately $2^3/_4$ oz. each. Not only do the tiles inherit the lightness of polystyrene but also the material's high dimensional stability. Because of these two characteristics and the square pan-like form of the shields, large panels of great rigidity can be constructed by welding together individual tile.

When individual tiles are joined by welding to other tiles, they create a panel having a criss-cross bracing on the coffer principle, assuring rigidity even in very large sizes. Used as shields below tube light installations, such large but extremely lightweight panels permit uninterrupted lighting of the entire area of the panel. And since only lightweight angles are needed to support these panels, others may be placed adjacent to them to form entire ceiling installations.

Panels made up of molded polystyrene lighting tiles offer a considerable safety factor. Glass shields are heavy, needing considerable mechanical support to hold them in position. Furthermore, suspended sections of glass are hazardous to the public safety. The plastic panels have no such limiting factors; because of their extremely light weight and toughness they offer no hazards, even if a panel should fall—a remote possibility since positive mounting methods can be used.

With the advent of 8-ft. fluorescent tubing and custom-made cold cathode types of tube lighting in long lengths, the need for strong large shields increased. The tubes themselves—constructed of fragile glass—become a source of danger in case of dislocation by vibration or insecure fastening. Polystyrene tile panels, suspended below such lights, prevent their falling and protect them from accidents that might occur because of exposed position.

### Light transmission properties

Because of the brilliant clarity of polystyrene, these lighting tiles in their crystal-clear form transmit from 88 to 92 degrees of light. By adding pigments in controlled proportions, exceptional diffusion of light can be obtained while maintaining high levels of transmission. These 6-in. square shields are now being molded in three standard types called bright white, warm white and clear. Each type is available in two forms, plain or prismatic. The following readings made on the plain pigmented tile give an indication of how well this product meets the requirements for lighting shields.

| | *Warm white* | *Bright white* |
|---|---|---|
| Apparent reflectance (versus magnesium carbonate), percent | 48.5 | 34.8 |
| Absolute reflectance (RMg CO3-97), percent | 50.0 | 35.8 |
| Total spectral transmission, percent | 38.5 | 54.5 |
| Diffusion factor, percent | 97.8 to 98.9 | 94 3 |

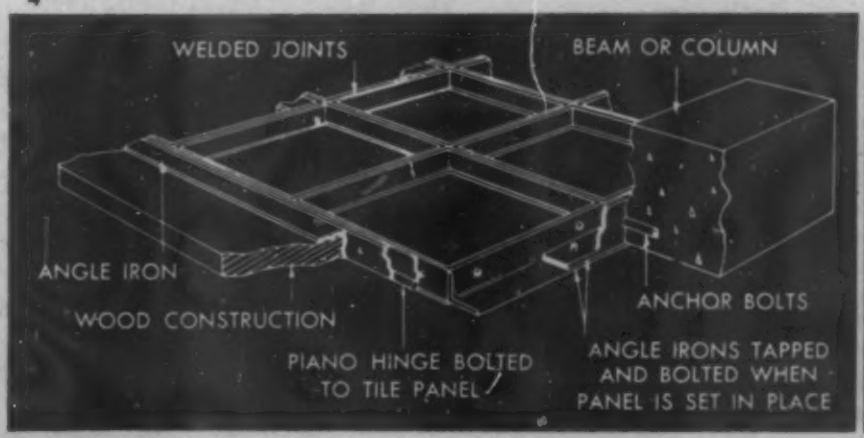
Prismatic tiles have entirely different transmission and diffusing characteristics. By the arrangement and angle of the prisms the light can be controlled and directed over specified areas or it can be generalized. Some prismatic arrangements will direct the light downward, focusing the light at determined distances from the source and creating greater intensities at these distances. Light transmission may also be blanketed directly under the fixture, lowering the surface brilliance yet directing considerable intensities of light horizontally without a very apparent loss of lumen output. Illustrative of this phenomenon is the reading taken on a clear prismatic polystyrene tile that showed total transmission of 83 percent yet the high diffusion factor of 95 percent.

Installation methods are many. One of the commonest is the framing of panels of this tile with wood or lightweight angles of metal or plastic. These angles are in turn fastened to opposing angles by means of clips, screws or catches. Variations of the methods include the use of piano-type hinges which simplify the problem of access to the tubes. The removable section system allows tile panels to be inserted into position and slid along opposing angle tracts followed by other panels which butt lightly against the preceding panels.

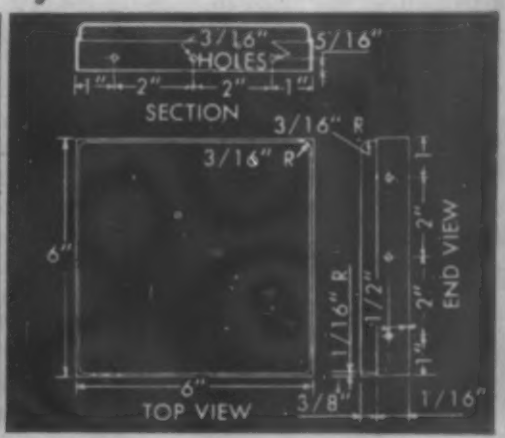
A common problem, particularly when old buildings are being renovated, is the lowering of ceilings. The lowering is a simple process, needing only a number of lightweight metal hang straps tied to the ceiling at intervals of 3 to 6 feet. Attached to these is a grill of "T" angles, made up in 3- or 4-ft. squares, covering all the ceiling area, or that portion to be lowered. Panels of tile, made up of these polystyrene squares fabricated to fit the size of the grill, are then inserted.

*4—Simple methods are employed to fasten panels to structural materials. Some of these are, use of angle irons, brackets and pins, studs and bolts.* **5**—*Detailed measurements of a 6-in. molded plastic tile*

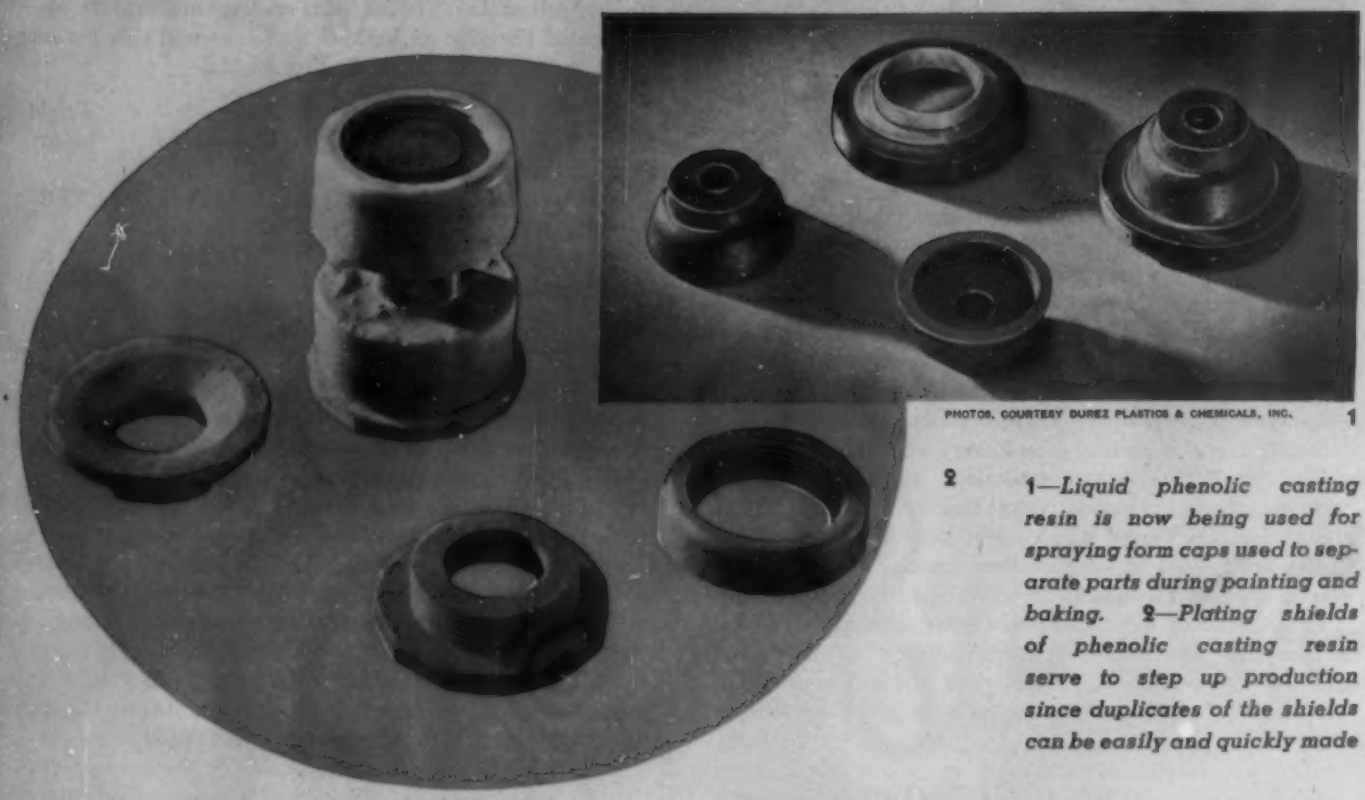
4


WELDED JOINTS
BEAM OR COLUMN
ANGLE IRON
WOOD CONSTRUCTION
PIANO HINGE BOLTED TO TILE PANEL
ANCHOR BOLTS
ANGLE IRONS TAPPED AND BOLTED WHEN PANEL IS SET IN PLACE

5



# Liquid casting resins prove versatile



PHOTOS, COURTESY DUREZ PLASTICS & CHEMICALS, INC. 1 2

*1—Liquid phenolic casting resin is now being used for spraying form caps used to separate parts during painting and baking. 2—Plating shields of phenolic casting resin serve to step up production since duplicates of the shields can be easily and quickly made*

JUST about three years ago liquid phenolic casting resins were introduced to the aircraft industry as materials for making forming dies for the very light metals in a faster, more economical way. Since then, many other applications for the casting resin have been developed, among them plating shields, separator masks, foundry patterns, forming dies and holding fixtures. The following brief accounts of these five applications should suggest other adaptations for casting resins, other industries in which they might be used with profit.

In none of the following items is the complete handling procedure discussed. Nor is particular mention made of the various types of parting agents which may be used with the several kinds of mold, the amounts of accelerator, the curing time, or any of the specific physical properties of the liquid phenolic casting resin. All these data are available in specific technical instructions from the manufacturer.

## Plating shields

The solution of a tin-plating problem encountered by one manufacturer was found to be in the use of a Durez liquid phenolic casting resin to duplicate an original plating shield that had been machined from a solid block of another cast resin. Molds were made from the halves of the original machined shield, and duplicate shields were produced quite rapidly with the liquid casting resin. This method of duplication had the further advantage of making possible the casting of the cathode as an integral part of the shield.

Figure 2 shows a typical shield used for tin-plating two caps at one time. In its production, one end was poured and allowed to set; then the other end poured. The resulting dual shield was oven-cured. The cap ends of the shield were also poured and baked. Since this resin has excellent dimensional stability, the threaded caps are all interchangeable.

To step up production, a dozen or more duplicate shields were made from this liquid phenolic casting resin. Usually six dual shields are attached to the electrode and placed in the tin-plating solution, 12 caps being plated at one time.

A sponge-rubber disk is cemented to the ends of the cathode which is cast in the shield. This set-up has two purposes: it insures a slightly tighter fit for the metal cap and it prevents the plating solution from acting on the reverse side of the slotted cap. The female threaded section of the resin shield, which is screwed down tight, keeps the plating solution away from the outside rim of the cap.

The two major results of adapting the liquid phenolic casting resin to this job were much faster production and considerably lower shield costs. Furthermore, the time required for making duplicate shields was cut down—casting of a piece of this type being a quicker way of duplicating than machining.

The small plating shield, which is also illustrated in the foreground of Fig. 2, consists of two parts, approximately 2 in. in diameter by $^1/_2$ in. in thickness. This unit was made from the same mold as the larger shield, only a slight change being necessary in the mold. It is used for chrome plating a similarly shaped metal part. Originally this part had been lacquered except for the surface to be plated, then plated, after which the lacquer was removed.

## Separator masks

Instead of replacing a lost punching die, which had been used for making spray form caps required for separating parts during painting and baking, one manufacturer cast the caps or separators in a Durez liquid phenolic casting resin.

The first step was the production of a mold into which the resin could be poured. This was readily accomplished by the simple expedient of using one of the original caps as a model and pouring the casting resin around it. Since close tolerance is not required, a chrome-plated steel plug is eye-centered in

this mold and new caps made quickly and easily from the casting resin. Wax can always be used as the parting agent.

These caps are subjected daily, for a short period, to an oven temperature of 350° F. Caps which have been through the oven for more than 1000 hr. show no evidence of deterioration. The manufacturer further reports that fewer rejects of painted parts have been encountered since these new plastic caps have been in use.

### Foundry patterns

At approximately one-eighth the cost of the original wood pattern, Bison Pattern Works duplicated the pattern shown in Fig. 5 for Metals & Alloy Specialties Co., using a liquid phenolic casting resin. Mounting the two patterns side by side, the company practically doubled its production.

This new adaptation of a plastic material, which is also an innovation in the foundry field, holds promise of a very interesting future because the cast resin patterns offer several advantages over the commonly used wood patterns. Of primary importance is the material's resistance to moisture and to atmospheric changes. Casting resin neither swells nor shrinks once it has been properly cured. It does not require reshellacking or refinishing, and its resistance to wear is excellent.

And the process of duplicating patterns in casting resin is comparatively simple. The duplication may be made in a plaster mold, a wood mold, a metal mold or a casting resin mold, and as many duplicates may be made from this mold as the production schedule demands.

These casting resin patterns are very light in weight, the resin having a specific gravity of about 1.25. This is a little more than the weight of mahogany, approximately one-half that of aluminum, and one-fifth the weight of cast iron.

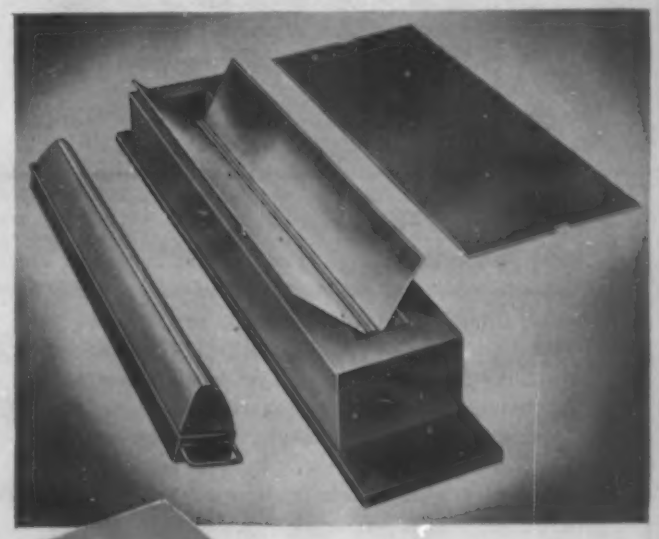
While the relatively low cost of this method of making duplicate patterns has proved of special interest, the fact that such duplicates can be made within a 24-hr. period is also of note. Cases on record show that a pattern can be ready for use in less than 3 hr. after the resin has been poured.

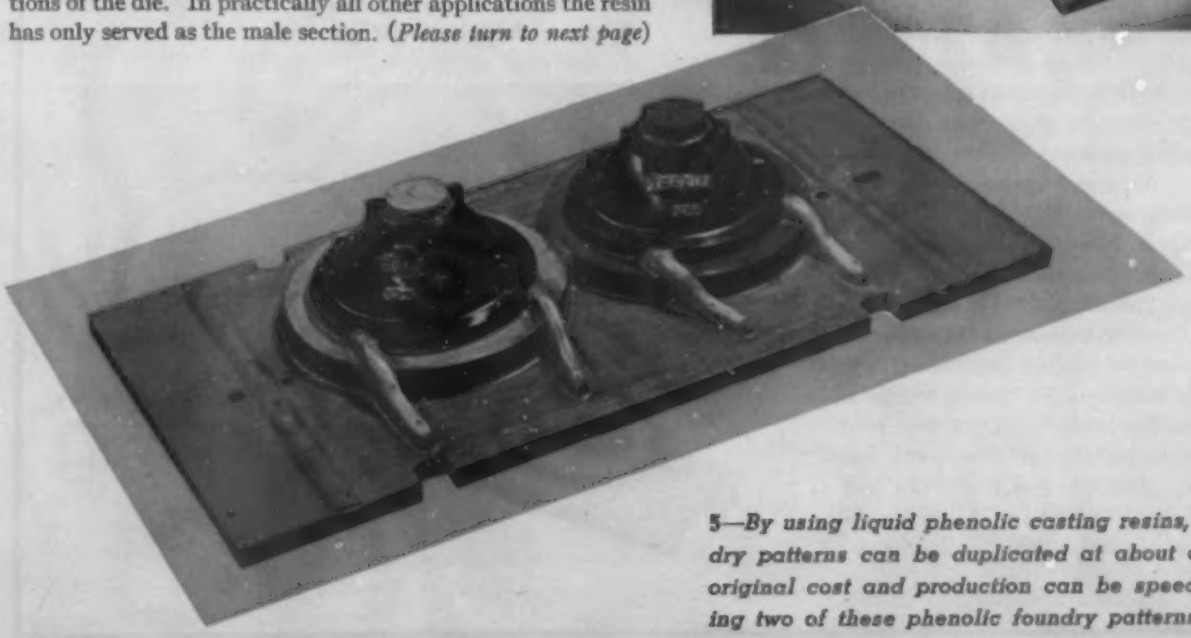
### Forming dies

Yet another manufacturer is making new use of a Durez liquid phenolic casting resin, this time for both parts of the forming die used in the production of an aluminum reflector. This is one of the very few cases presently on record where the casting resin has been used for both the male and female sections of the die. In practically all other applications the resin has only served as the male section. (*Please turn to next page*)

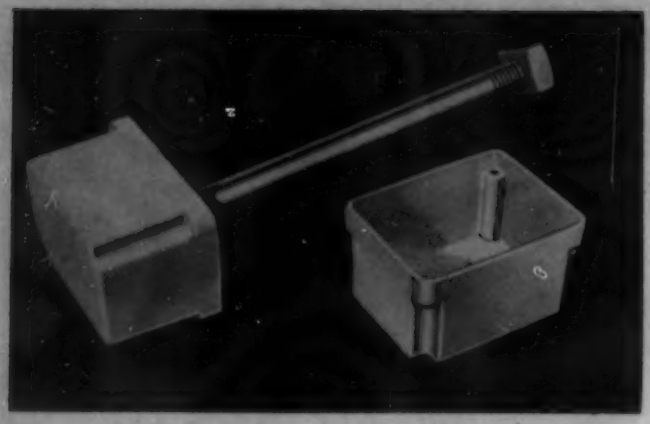
**3**—*Liquid phenolic casting resins are also being used for both male and female parts of a forming die turning out aluminum reflectors. A power operated brake is employed*

**4**—*The three elements which are involved in the forming of the aluminum reflectors are: the flat sheet (right) the female mold (center) and the force plug (left)*





**5**—*By using liquid phenolic casting resins, wooden foundry patterns can be duplicated at about one-eighth the original cost and production can be speeded by mounting two of these phenolic foundry patterns side by side*



*6—Small holding fixtures are a further application of these materials. After the resin is poured in a die-cast cover, the stud is inserted in its proper place and the assembly cured in an oven at a prearranged heat*

Of equal interest and note is the fact that this die is being used on a power-operated brake and not on the usual hydropress or stretchpress. The pounds per square inch pressure to be exerted on the plastic die caused the manufacturer's engineers some concern when this low-cost method was first suggested. However, disregarding precedent, the Bennett Manufacturing Company undertook production of the reflectors with this new method and have reported highly satisfactory results. About 2000 reflectors of 0.020 aluminum (24 gage) have been formed in the die shown in Fig. 3 and no signs of wear are yet evident.

Although the female section of the die is approximately 10 in. high and the male section 6 in., there is adequate stroke on the brake to permit good, economical production. Furthermore, it is reported that the surfaces of the formed reflector have a more consistent smoothness than is usually obtained when forming dies made of other materials are used.

No definite explanation has been advanced for this circumstance except that it may be due to the surface texture of the plastic or its lower coefficient of friction. It is well known in industry that phenolic resins incorporated with other materials make excellent bearings. It seems only reasonable to assume that the same properties which make that statement true also contribute to the success of the phenolic resins in casting the forming dies.

## Holding fixtures

Still another application of the Durez liquid phenolic casting resin is the small holding fixture shown in Fig. 6. One of the die-cast covers was coated with the proper parting agent and the resin poured into the cover. The stud (machine bolt) was inserted in the resin and located in its proper place. This assembly was then placed in an oven and cured for the necessary period of time at 140° F. When taken from the oven the die-cast cover was removed and the fixture was ready for use—the stud being anchored securely in the cast resin.

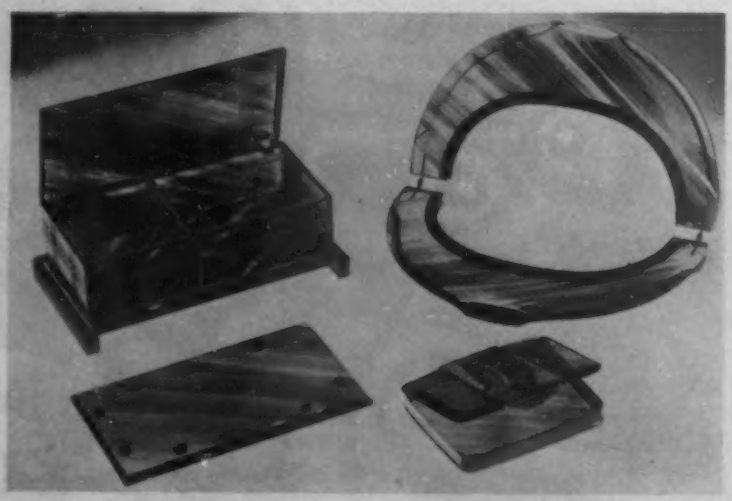
This fixture is used for holding the die-cast covers while a few finish-filing operations are performed. It is remarkably light in weight, has excellent wearing qualities, and may be easily and economically replaced or duplicated should production requirements so demand.

COLOR IS ALWAYS IN FASHION—BUT THE fashion in color changes from season to season and varies according to the taste of the purchaser. This means that producers of plastic merchandise must make their items available in a wide range of colors. And they must be in a position to alter the color or the pattern of color on very short notice.

One solution to this difficulty is to dye plastic merchandise after fabrication. In this way, small lots of compacts made from Transparent sheet stock can be turned out in almost every color of the rainbow. Another advantage of dyeing is that very exacting color patterns can be achieved in the finished product. For example, simulated tortoise shell presents no insurmountable problem to the dyer of plastic products.

The handbag frames, cigarette case and cigarette box shown in the accompanying illustration were all dyed by Plastic Color Products. This company's experience indicates that acrylic, acetate and clear phenolic materials are the plastics best suited to this method of coloring. By careful timing and by varying the intensity of the dye, plastic pieces can be matched to almost any specified color. And this coloring is not just a surface finish. Tests have shown that the dye penetrates the plastic to a depth of about $^1/_{10}$ in. which means that the material can be buffed without danger of the color disappearing.

A pattern of color, such as is shown in the four articles illustrated here, is put on by hand after the plastic pieces have been dyed an even basic color. This hand work permits of a high degree of control over the placement and the intensity of the darker color markings. While many of the plastic items that are dyed by this company are in a finished state, others must be formed to the desired shape after dyeing. These dyes are not affected by heat and light.



ALL PHOTOS, COURTESY U. S. PLYWOOD CORP.

*An autoclave used for the production of molded plywood and low pressure plastics. The part to be molded is on a form in the rubber bag. While the man on the right seals the bag opening, the man on the left is connecting the vent line to the rubber bag*

# How and why of low-pressure molding

by CHARLES B. HEMMING*

**Low-pressure molding which is the technique of forming flat, simple- or compound-curved parts by means of pressures under 500 p.s.i., may be divided into four classifications—laminating, gluing to contour, plastic forming and resin curing to contour**

WHENEVER low-pressure molding comes up for discussion it soon becomes evident that there is considerable confusion as to just what is meant by "low-pressure molding". Before long a debate will be raging as to what constitutes low pressure. Staunch advocates can be found for practically all pressures between 1000 and 0 p.s.i. Since the pressures in the upper edge of this range are not exactly low, bystanders often come to the conclusion that low-pressure molding is an ill-defined term adopted by an industry that does not yet know its own mind.

This confusion is not difficult to understand when it is realized that low-pressure molding is actually the extension of a group of old ideas which was made possible by new materials. These variations of opinion as to what constitutes low pressure are not, however, of great consequence and merely reflect the early experience of the persons making the statement.

Another point of confusion, more prevalent outside the industry than in it, concerns the nature of the forming dies that are used. In this respect there is a greater departure from past practice than in the case of pressure. But here, too, the extension of an old idea is involved.

After emphasizing the principal confusions surrounding the subject of low-pressure molding, it remains to define the art. Low-pressure molding is the technique of forming flat, simple- or compound-curved surfaces, in material capable of permanent deformation, by means of pressures under 500 p.s.i. with particular emphasis on pressures below 100 p.s.i. Low-pressure molding may be further described by classifying the principal techniques in terms of the operations involved. These are as follows:

* Chief chemist, U. S. Plywood Corp.

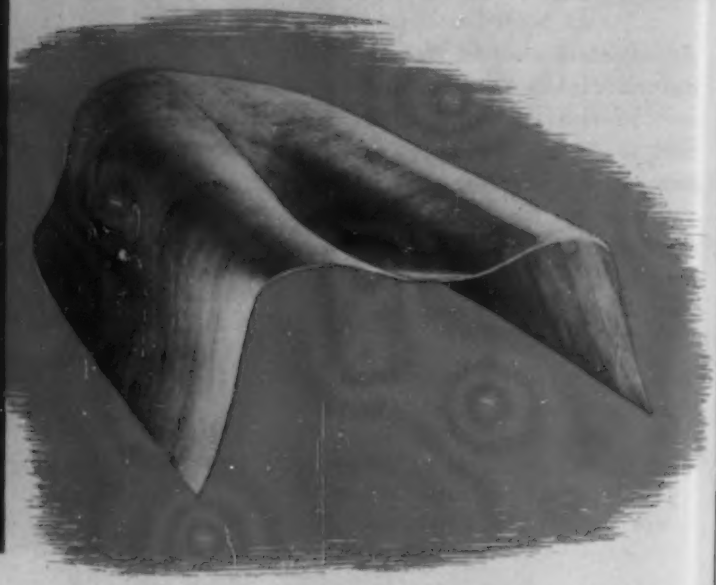
## Laminating

As the name implies, this technique is directed toward the forming together in the desired shape of multiple layers or laminae of paper or fabric previously impregnated with resinous material which is generally heat sensitive and capable of holding the laminae together so that they no longer act as individual layers but behave as a solid member.

## Gluing to contour

This technique includes the much-publicized molded plywood as exemplified by the so-called Vidal and Duramold molding processes. Laminated wood arches and small boat keels also come under this heading. The laminae are generally stiff and thick enough so that they have the tendency to behave as solid members before molding or gluing. These laminae—veneer in the case of wood—are coated with a plastic substance which is generally heat sensitive. As a result, when the individual plies are forced together into the desired shape they are permanently held in place.

The necessary equipment peculiar to gluing to contour comprises male or female forms, molding bags and a pressure vessel such as an autoclave. Auxiliary equipment includes a



*Left—A male form and a molded part which have just been removed from the form. Note the slots in the form which permit the molding of ribs as an integral part of the skin. Below—This Army boat hull, which is 18 ft. long and has a beam of 6 ft. 8 in., features a tunnel bottom cast in one piece. It is constructed of resin-impregnated Birch*

high-pressure steam boiler compressor, air receiver and vacuum pump.

The male molding form is generally built up of layers of wood, about one inch thick, glued together and then shaped after the fashion of a pattern. The finished *exterior* contour of a male form corresponds to the *interior* contour of the molded part.

If a female molding form is preferred, it can be made quite simply of metal or some form of low-pressure plastic using a male pattern very similar to the male molding form. But in contrast to the measurements of the male mold, the *interior* contour of a female molding form must be that of the *exterior* contour of the part. To achieve these measurements, it is necessary that the *exterior* contour of the pattern used in the construction of the female mold equal the *exterior* of the finished part.

A number of considerations—one of which is the surface smoothness desired in the finished part—affect the choice of a female or male mold. The surface of the part in contact with the mandrel is always the smoother. So, if one surface must be smoother than the other, that form should be chosen which will bring the critical surface in contact with the mold during forming. Need for reinforcing members or ribs is another factor which influences the type of mold that is used. A male form can be grooved to permit simultaneous molding of reinforcements and parts into one strong, integral unit.

Molding bags are generally made of rubber or rubberized fabric. They may be loose or form fitting and "envelope" or "half-bag". The envelope types have an open end to receive the part after lay-up on or in the form. This open end is closed by clamps or any device that is fluid-tight. The half-bag types are dropped over the part and sealed by clamping to a flat plate or flange on the form. All bags must, of course, have a vent line attachment to permit the expulsion of air or other vapors which would prevent the bag from pressing snugly into contact with the laid-up part which, in turn, is thus held tightly against the molding form.

Most commonly, the pressure vessel is an autoclave with connections passing through its wall to permit the venting of the bags to the outside air, either directly or through a vacuum pump. A means of introducing water spray while maintaining pressure is also desirable. Perforated pipes or spray heads can be used for this purpose.

In order to maintain pressure while cooling and to obtain various combinations of temperature and pressure other than those fixed by the properties of saturated steam, a source of compressed air is also necessary. For efficiency and safety the equipment should be complete with after-cooler, separator and receivers—elements which are all too often and unwisely omitted to the detriment of the bags and with increased liability of air line or autoclave explosions.

The vacuum pump requirements are not unique but it is recommended that the driving motor be a size larger than normal so the pump can be run continuously at maximum vacuum without overheating. As a protection to the pump, a receiver should be installed between the autoclave vacuum outlets and the pump.

### Plastic forming

This particular technique includes the deformation to the desired shape of substances generally thermoplastic in nature. Laminating may or may not be involved. The change of form is achieved by means of elevated temperatures and is made permanent, at least at room temperature, by cooling under pressure. The principal examples of material molded in this manner are Polyfiber, Polyflex, Lucite and Plexiglas sheet and Polyfoam. The various thermoplastic hard sponge rubbers are also molded in this way.

### Resin curing to contour

This technique, which is related to simple resin casting, has been made important by the advent of practical, economical, so-called no-pressure or contact-pressure resins—polyester resins, to describe them more specifically. In this method, thin laminae—generally fabric—saturated with polyester resin in the monomeric stage are brought into contact. The polymerization of the resin serves to hold the laminae in permanent contact and to the chosen shape.

TABLE I—MOLDED WELDWOOD PLYWOOD TUBING[a,b]

| Specimen | Wt./lin.ft. | Molulus of elas. | Comp. stress at prop. limit | Ultimate comp. stress | Moldulus of rupture | Moment of inertia |
|---|---|---|---|---|---|---|
| | lb. | p.s.i. | p.s.i. | p.s.i. | p.s.i. | in.⁴ |
| 4 O.D. by 0.38 W.T. | 1.4 | 1,500,000 | 3500 | 6000 | 12,000 | 6.6 |
| 3 O.D. by 0.28 W.T. | 0.78 | 1,500,000 | 3500 | 6000 | 12,000 | 2.2 |
| 6 O.D. by 0.46 W.T. | 2.6 | 1,500,000 | 3500 | 6000 | 12,000 | 29.4 |

a Material—all birch.
b All values corrected to 12 percent M.C.

It was pointed out at the beginning of this article that low-pressure molding was made possible largely by the development of new materials. This statement can be best appreciated after consideration of synthetic resins formulated to produce satisfactory laminates at such widely different pressures as 2000, 1000, 500, 100 and 30 p.s.i. or even mere contact. While any one resin will perform fairly well over a rather wide range of pressures, resins can be formulated to give best results at the pressures named.

To carry on an illustrative experiment one should obtain representative samples of these several resins and use them to impregnate portions of any suitable laminating paper for each resin. In each case, the resin should be impregnated into the paper to the degree recommended, and the impregnated paper should be dried to the point advised for its use. If each of the impregnated papers is then laminated at the pressure recommended as suitable for its resin, it will be surprising and interesting to see how excellent is each laminate.

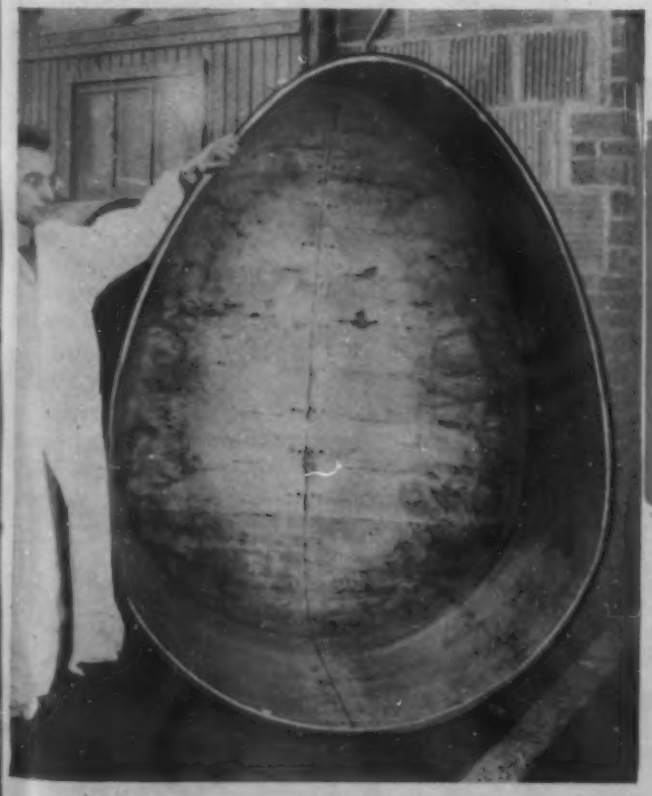
If, then, the paper impregnated with the highest pressure resin is laminated at decreasingly lower pressures, the quality will become poorer and poorer until, at pressures much lower than recommended, the result will be rather disappointing. The reverse is also true, but to a lesser extent. If one of the very low-pressure resins is laminated at very high pressure, excessive squeeze-out or flash will generally occur and there is considerable likelihood that unlaminated areas or blisters will be formed.

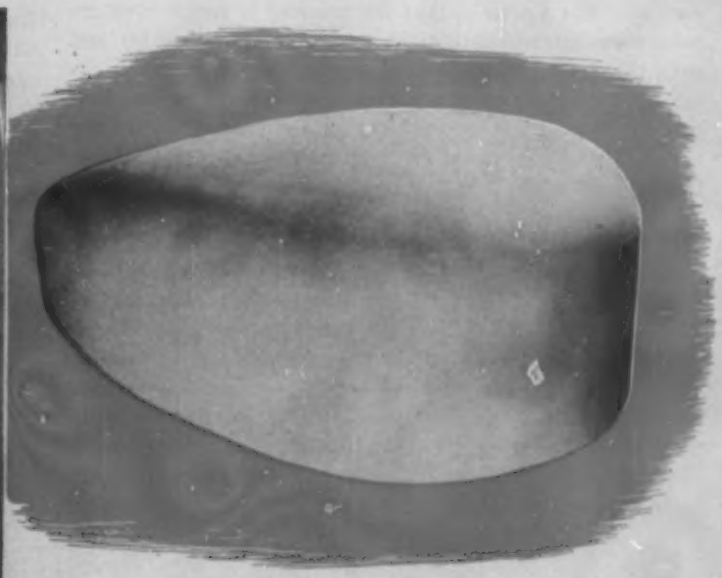
## How the techniques were evolved

For many years the so-called mechanical rubber goods, which include rubber boots, hose, and a host of flexible rubber products other than tires and tubes, have been made by wrapping alternate layers of uncured gum rubber and fabric over male molds, placing them in an autoclave and introducing steam into the autoclave to furnish heat and pressure. This introduction of steam not only acted to force the rubber into tight contact with the mold but to cure or vulcanize it.

It was not a great step to substitute resin impregnated or coated thin flexible material for the rubber and fabric layers and then to encase the whole assembly in a large rubber bag before placing it in the autoclave for exposure to heat and pressure. Enclosure in the rubber bag did, however, add one complication. Some way had to be found to extract from the bag the air and any gases that formed or were driven from the part being molded as the heat was applied.

This problem was solved by attaching one end of a length of tubing to the rubber bag and the other end to a nipple leading through the wall of the autoclave. Thus, the inside of the bag in which the part to be molded has been placed, is maintained at atmospheric pressure even though the outside of the bag is subject to the pressure existing in the autoclave. A molding force then results which holds the laminae or the plastic tightly against the form until the resin is reacted so that desired shape is held. (*Please turn to next page*)





***Left—This female low-pressure molding form contrasts with the form shown in Fig. 2. It is representative of the forms used to produce radomes. Above—This semi-streamlined fibrous polystyrene radome illustrates the result obtained from the plastic forming process***

*This capsule-shaped radome made of glass fiber cloth and polyester resin demonstrates resin curing to contour*

*Hat press method*—A variant of this technique, called the hat press method owing to the fact that it was borrowed from the process of making felt hats, puts the pressure in the molding bag. In this case a female form is used which can be capped with a lid to confine the bag.

*Vacuum-pressure technique*—A more recent and a logical extension of the technique is vacuum-pressure molding, in which the air is merely exhausted from the bag in which the part has been placed so that the pressure of the atmosphere pushes the laminae into tight contact with each other and with the mold. Heat is then applied to the assembly by means of a hot-air oven, a hot room or banks of radiant heat lamps. Since the maximum pressure obtainable is slightly under 15 p.s.i., the newer contact or polyester resins are particularly suited for this type of molding.

## Low-pressure versus high-pressure molding

At this point it may well be asked, "what good is low-pressure molding," "why was it developed," "what can be done with it?" For answer we turn again to past history. In high-pressure molding the form used is in reality two dies which mate. One is called the female part and one the male part. Because of the pressure involved, these parts must be very strong; because the resins used in high-pressure molding exhibit very little flow, clearances in the dies must be very accurately uniform. Dies that meet these qualifications are costly and a large number of parts must be produced to amortize the cost of the molds.

With this picture in mind, visualize the dies required for the high-pressure molding of a relatively simple form consisting of a cylinder attached to a hemisphere, the diameter of the cylinder being about 3 ft. and the height of the combination about 4 feet. Even if the necessary dies could be made, the force required to close them at even the lower range of high-pressure molding would be enormous.

However, since new resins have made very low pressures possible, it becomes feasible to make forms, or mandrels, out of laminated wood much after the fashion of pattern making, or out of light metal or various types of plaster and cement. It also becomes feasible to use a system in which one of the two members of the die is a flexible membrane such as a rubber bag. The bag becomes the "indefinite" die, and the molding form, which may be either male or female, is the "definite" member. Since this arrangement permits the production of large parts at relatively low cost, it is practical to make prototypes, and small runs are reasonably economical.

Still another and very important advantage of these new techniques is that the laminae do not lose all individual indentity as molding materials do in high-pressure molding. Because of this, sandwich constructions are possible in which strong, thin skins are molded on to a lightweight core material which serves the principal purpose of keeping the skins apart. Strength-weight ratios can be controlled through the proper choice of fabric, paper, veneer or combinations of these materials. Special electrical qualities can be obtained, particularly as they relate to dielectric constant, loss tangent and surface resistivity. While it is true that all of these effects are available to a limited extent in high-pressure molding, the degree to which they can be varied is relatively small.

## Products of low-pressure molding

Examples of the products of low-pressure molding are boat hulls; plywood, laminated paper or fabric tubing, streamlined aircraft housings of various sorts; farings, seats, and even wing structures and fuselage structures. Structural forms such as "U"- and "C"-shaped channels and angles can also be made by this method.

Pertinent strength data on parts and material made by one or the other of the methods described earlier in the article are given in the following tables. Table I describes test results on molded Weldwood plywood tubing. The glue lines of this tubing easily surpass the minimum requirements of Specification ANP-43 which calls for a dry shear strength of not less than 380 p.s.i. and a wet shear strength of not less than 290 p.s.i. after a 3-hr. boil.

Table II describes test results on Tempreg A, a low-pressure phenolic resin impregnated paper laminate of excellent dimensional stability which is being used in the form of compound curved parts, flat sheets and tubing. The material is unusual in that very narrow thickness tolerances can be met. An unusually thin sheet or tube such as 0.015 in. plus 0.000, minus 0.002 in. can be produced in quantity without sanding.

TABLE II—TEMPREG A

| *Specimen* | *Ultimate tensile stress* | *Modulus of elas.* | *Modulus of rupture* | *Ultimate comp. stress* | *Impact Izod lb./in. of notch* | *Specific gravity* |
|---|---|---|---|---|---|---|
| | *p.s.i.* | *p.s.i.* | *p.s.i.* | *p.s.i.* | | |
| Cross laminated | 25,000 | $2.5 \times 10^6$ | 25,000 | 49,000 | Notched flatwise 2.1 | 1.37 |
| | | | | | Notched flatwise 0.5 | 1.37 |
| Parallel laminated | 33,000 | $3.2 \times 10^6$ | 33,000 | 38,000 | Notched flatwise 2.8 | 1.37 |
| | | | | | Notched flatwise 0.6 | 1.37 |

Test data on a phenolic resin impregnated Fiberglas cloth laminate which has the special additional requirement of a surface resistance over a 6 in. span in any direction of between 10,000 ohms is listed in Table III. In a part having severe compound curvatures, this requirement is not easily met.

Table IV describes the strength data of a special lightweight all-plastic sandwich construction in which the skins are Fiberglas cloth and the core is hard synthetic rubber sponge having a number of additional critical requirements among which are uniformity of thickness within ± 0.020 in. on a thickness of $^1/_2$ inch.

The strength properties of flat plywood made according to Specification AN-NN-P511b are well known. Molded plywood can be made to conform generally to the same requirements which are more specifically outlined in Specification ANP-43. When so made, the molded plywood is found to have the same mechanical properties as the flat plywood, making due allowances, of course, for the curvatures involved.

## Hard facts, not glamour

Of course, while listing examples of what can be done with low-pressure molding techniques, one could go on and include such things as bathtubs, bicycles, futuristic furniture and automobile bodies. Strictly speaking, such things are possible, but there has been a deplorable tendency to put too much glamour into discussions involving plastics. There is a very real fear on the part of those sincerely interested in the future of plastics that the public will come to distrust all claims for plastics as being grossly exaggerated. Saner heads are urging that plastics are not a cure-all—nor is low-pressure molding. In my opinion, widespread use of these techniques will exist only where real contributions, and not mere duplication of more orthodox methods, result.

## Postforming and other techniques

It is more likely that borderline techniques will play a part in the modification of some of the articles with which we come in daily contact. One of these borderline techniques is related to low-pressure molding and is mentioned here briefly for the sake of completeness. This is postforming. Although there are those who would object to the statement, postforming is merely an extension of the time-honored practice of bending wood after steaming in the manner used to shape ribs for small boats and canoes. Bending of wood and plywood has been modernized to some extent by means of chemical treatments which increase the plasticity of the wood. But the modern acceptance of the term postforming brings to mind the bending to contour under heat and pressure of already-cured laminates such as phenol-formaldehyde resin impregnated fabric or paper. Postforming also includes a very recently developed technique wherein polyester resins are polymerized to what is termed the gel point in flat sheets and then formed to the final curved shape by reapplication of pressure and by continuation of heat. The cross-linking of the resin is thus secured and the deformation is permanent.

TABLE III. PHENOLIC RESIN IMPREGNATED FIBERGLAS CLOTH LAMINATE[a,b]

| | |
|---|---|
| Ultimate tensile stress, p.s.i. | 14,900 |
| Moldulus of elas., p.s.i. | 1,540,000 |
| Ultimate comp. stress flatwise, p.s.i. | 35,400 |
| Modulus of rupture, p.s.i. | 12,600 |
| Ultimate bearing, p.s.i. | 24,500 |
| Specific gravity | 1.65 |

[a] Cross laminated.
[b] Laminate developed by U. S. Plywood Corp.

TABLE IV.—ALL-PLASTIC SANDWICH CONSTRUCTION

| | |
|---|---|
| Weight per sq. ft. | 1.0 |
| Edgewise compression, p.s.i. | 2300 |
| Edgewise compression p.s.i. of skin | 16,000 |
| Tensile stress perpendicular to skins | 300 |
| Stiffness (E.I.), lb./in²/in. | 5000 |
| Nominal core density, lb. per cu. ft. | 12 |


## Acknowledgments

The writer wishes to express his appreciation for the valuable assistance of the various members of the engineering staff of United States Plywood Corporation and particularly to T. R. Foster, assistant chief engineer, in furnishing and arranging the engineering data used herein.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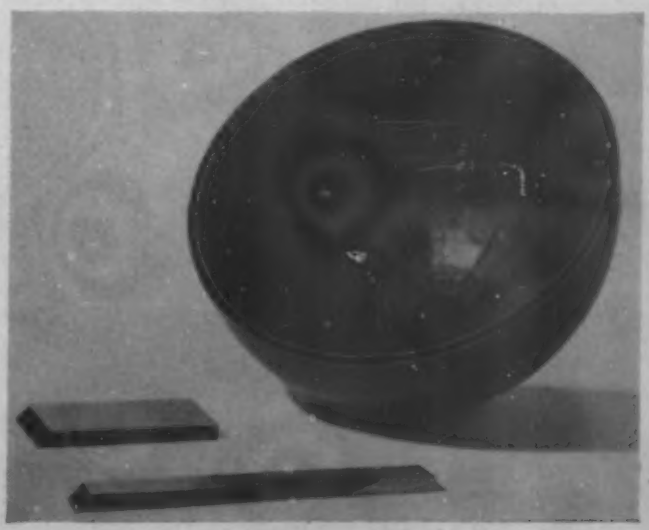
***This plastic sandwich construction was molded by means of low pressure, and is a good example of engineered molding. A flat panel is sliced to reveal glass fiber cloth-polyester resin skins adhered to hard synthetic rubber foam***



# Classification of molding materials

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The Society of the Plastics Industry, Inc., has just issued a Classification of plastics molding materials, the result of over two years of concentrated effort on the part of technicians in the plastics industry. Aimed to provide data comparable to that which has been available to those employing wood, metals and other materials in their operations, the classification presents in chart form an authentic guide to the various properties of plastics molding materials as established by the material producers and molders.

Modern Plastics has reproduced this Classification in full on the tip-in chart which accompanies this brief description. To simplify the use of this table we have inserted on the bottom of the chart a short paragraph on "how to use the chart." A complete and detailed guide, or scope as it is called, can be obtained from the Society of the Plastics Industry, Inc., 295 Madison Avenue, New York 17, N. Y.

The SPI Classification is intended to promote and encourage the intelligent use of plastics. Designed to establish an engineering approach to the selection of the proper plastic material for specific applications, the chart and Scope mark the first step in the SPI technical program. As with engineering data covering metals, wood or any other materials, the plastic technicians who are responsible for the classification table have assumed that it will be used principally by individuals with a working knowledge of plastics, including its compounding, testing, molding and application.

This Classification, drawn up to aid engineers, designers, molders and others, makes possible the coverage of a wide range of physical properties for the various plastics from which the engineer can readily make a more intelligent selection of material. The chart includes thermoplastic and thermosetting materials, listing numerous properties of molding powders, either as resins and plastics alone, or when intimately combined with fillers, pigments and dyes. Only commercially available materials are covered. As soon as new plastics reach consumer importance, they will be added to the chart.

The table gives values for mechanical, electrical, optical, thermal, chemical and aging properties of molding materials normally known as rigid plastics. The data have been submitted by qualified sources such as the American Society for Testing Materials, the National Bureau of Standards and the Joint Army-Navy Plastics Specifications. The values used as a basis for the Classification were obtained at room temperature under standard test conditions; and properties may differ appreciably above or below room temperature. For some plastics and some properties this difference will be negligible. However, in most cases it will be appreciable and must be carefully considered if the application involves wide temperature ranges.

Properties shown have in most cases been determined by the American Society for Testing Materials' test methods. In general the data represent *minimums* for such values as impact, tensile, flexural strength, water absorption, etc. The different materials described by the grade numbers and suffix letters will have properties within the bounds given by the figures in the table. This is obviously a conservative approach to the publication of data and was adopted, after extensive consideration, in order to provide adequate safety factors in design. Of course, proper design has an important bearing on the final properties obtainable in the molded part and also on the method of molding.

It will be noted that there are several columns on the chart that contain no values. Subsequent revisions of the Classification will include values and test methods as they become available. The importance of the property columns showing no data makes it imperative that they be contained in this initial publication.

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# THE SOCIETY OF THE PLASTICS INDUSTRY

## CLASSIFICATION OF PLASTIC MOLDING MATERIA

(FOR FURTHER EXPLANATION READ SCOPE)

| GRADE NUMBER | BASIC REQUIREMENTS | | | | | REQUIREMENTS ADDED BY SUFFIX LETTERS | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | SOURCE OF SPECIFICATION | | | MECHANICAL PROPERTIES | | | | | ELECTRICAL PROPERTIES | | | | | | | | | | | |
| | Heat Distortion Temp. °F 264 PSI Fiber Stress ASTM D648-41T | Impact Strength Izod Ft.-lbs. per in. notch ASTM D256-43T | Tensile Strength PSI ASTM D638-42T (3) D638-44T (3) D651-44T (4) | Maximum Continuous Service Temp. °F (2) | Heat Distortion Temp. °F 66 PSI Fiber Stress ASTM D648-44T | Material Basic Chemical Analysis (1) | American Society for Testing Materials | Federal | Joint Army-Navy (JAN) | Flexural Strength PSI Fed. Spec. 1031 ASTM D650-42T ASTM D48-43T (5) | Compressive Strength PSI ASTM D695-42T ASTM D649-42T (6) | Modulus of Elasticity in Tension PSI×10⁶ (7) | Hardness Rockwell (8) | Specific Gravity ASTM D792-44T (10) | Power Factor ASTM D150-42T Cycles | | | Dielectric Constant ASTM D150-42T Cycles | | | Dielectric Strength Volts per Mil ASTM Short Time | Dielectric Strength Volts per Mil D149-44T Step by Step | Volume Resistivity Meg-Ohms CM ASTM D257-38 | Insulation Resistance Meg-Ohms ASTM D257-38 |
| | | | | | | | | | | | | | | | 60 | $10^3$ | $10^6$ | 60 | $10^3$ | $10^6$ | | | | |
| | MIN. | MIN. | MIN. | MAX. | MIN. | X | Sa | Sb | Sc | Ma | Mb | Mc | Md | Mf | Ea | Eb | Ec | Ed | Ee | Ef | Eg | Eh | Ei | Ej |
| SPI 10232 | 100 | 2.3 | 2000 | | 140 | CAB | D707-7 | | | | | | | 1.19 | | | | | | | 250 | | | |
| SPI 10252 | 100 | 2.5 | 2000 | | 130 | CAB | D707-10 | | | 3200 | | | | 1.21 | | | | | | | 250 | | | |
| SPI 10302 | 100 | 3.0 | 2000 | | 120 | CA | D706-11 | | | | | | | 1.32 | | | | | | | 250 | | | |
| SPI 10311 | 100 | 3.1 | 1000 | | 130 | CAB | D707-8 | | | 1600 | | | | 1.18 | | | | | | | 250 | | | |
| SPI 11172 | 110 | 1.7 | 2000 | | 140 | CA | D706-4 | | | 4000 | | | | 1.37 | | | | | | | 250 | | | |
| SPI 11173 | 110 | 1.7 | 3000 | | 140 | CAB | D707-9 | | | 4200 | | | | 1.22 | | | | | | | 250 | | | |
| SPI 11182 | 110 | 1.8 | 2000 | | 150 | CAB | D707-2 | | | 3700 | | | | 1.20 | | | | | | | 250 | | | |
| SPI 11203 | 110 | 2.0 | 3000 | | 150 | CA | D706-15 | | | 3500 | | | | 1.37 | | | | | | | 250 | | | |
| SPI 11223 | 110 | 2.2 | 3000 | | 130 | CA | D706-10 | | | | | | | 1.32 | | | | | | | 250 | | | |
| SPI 11304 | 110 | 3.0 | 4000 | | | EC | D787-4 | | | 5000 | | | | 1.19 | 0.01 | 0.03 | 0.03 | 4.0 | 3.8 | 3.7 | 350 | | | |
| SPI 11504 | 110 | 5.0 | 4000 | | | EC | D787-7 | | | | | | | 1.09 | | | | | | | 250 | | | |
| SPI 12027 | 120 | 0.2 | 7000 | | | VCA | D728-1 | | | 12000 | 9000 | | | 1.35 | | | | | | | | | $10^8$ | |
| SPI 12034 | 120 | 0.3 | 4000 | | | VCA | D728-2 | | | 7500 | 9000 | | | 1.40 | | | | | | | | | $10^8$ | |
| SPI 12104 | 120 | 1.0 | 4000 | | 160 | CAB | D707-3 | | | 6100 | | | | 1.23 | | | | | | | 250 | | | |
| SPI 12123 | 120 | 1.2 | 3000 | | 150 | CAB | D707-4 | | | 5000 | | | | 1.22 | | | | | | | 250 | | | |
| SPI 12133 | 120 | 1.3 | 3000 | | 140 | CA | D706-3 | | | 5500 | | | | 1.37 | | | | | | | 250 | | | |
| SPI 12144 | 120 | 1.4 | 4000 | | 160 | CA | D706-14 | | | | | | | 1.34 | | | | | | | 250 | | | |
| SPI 12153 | 120 | 1.5 | 3000 | | 160 | CAB | D707-1 | | | 5100 | | | | 1.21 | | | | | | | 250 | | | |
| SPI 12174 | 120 | 1.7 | 4000 | | 150 | CA | D706-8 | | | | | | | 1.32 | | | | | | | 250 | | | |
| SPI 12193 | 120 | 1.9 | 3000 | | 140 | CA | D706-9 | | | | | | | 1.32 | | | | | | | 250 | | | |
| SPI 12355 | 120 | 3.5 | 5000 | | | EC | D787-3 | | | 6000 | | | | 1.18 | 0.01 | 0.03 | 0.03 | 4.0 | 3.8 | 3.7 | 350 | | | |
| SPI 12505 | 120 | 5.0 | 5000 | | | EC | D787-6 | | | | | | | 1.12 | | | | | | | 250 | | | |
| SPI 13015 | 130 | 0.1 | 5000 | | 170 | MM | D788-3 | | | 12000 | | | | 1.20 | 0.07 | 0.06 | 0.04 | 4.0 | 4.0 | 3.0 | 400 | 350 | $10^8$ | |
| SPI 13025 | 130 | 0.2 | 5000 | | 170 | MM | D788-1 | | | 12000 | | | | 1.20 | 0.07 | 0.06 | 0.04 | 4.0 | 4.0 | 3.0 | 400 | 350 | $10^8$ | |
| SPI 13035 | 130 | 0.3 | 5000 | | | VCA | D728-3 | | | 8000 | 9000 | | | 1.40 | | | | | | | | | $10^8$ | |
| SPI 13104 | 130 | 1.0 | 4000 | | 160 | CA | D706-2 | | | 7000 | | | | 1.37 | | | | | | | 250 | | | |
| SPI 13104-2 | 130 | 1.0 | 4000 | | 180 | CAB | D707-6 | | | 6900 | | | | 1.22 | | | | | | | 250 | | | |
| SPI 13355 | 130 | 3.5 | 5000 | | | EC | D787-2 | | | | | | | 1.15 | | | | | | | 350 | | | |
| SPI 13506 | 130 | 5.0 | 5000 | | | EC | D787-5 | | | | | | | 1.14 | | | | | | | 250 | | | |
| SPI 14085 | 140 | 0.8 | 5000 | | 180 | CA | D706-1 | | | 8500 | | | | 1.37 | | | | | | | 250 | | | |
| SPI 14085-2 | 140 | 0.8 | 5000 | | 170 | CA | D706-7 | | | 6000 | | | | 1.37 | | | | | | | 250 | | | |
| SPI 14115 | 140 | 1.1 | 5000 | | 120 | CA | D706-13 | | | | | | | 1.34 | | | | | | | 250 | | | |
| SPI 14256 | 140 | 2.5 | 6000 | | | EC | D787-1 | | | | | | | 1.14 | | | | | | | 350 | | | |
| SPI 15064 | 150 | 0.5 | 4000 | | | VC | D729-1 | | | 15000 | | | | 1.75 | 0.042 | 0.075 | 0.065 | 5.1 | 4.2 | 3.3 | 350 | 300 | $10^8$ | |
| SPI 15055 | 150 | 0.5 | 5000 | | 190 | CA | D706-6 | | | 8000 | | | | 1.37 | | | | | | | 250 | | | |
| SPI 15065 | 150 | 0.6 | 5000 | | 190 | CAB | D707-5 | | | 8500 | | | | 1.23 | | | | | | | 250 | | | |
| SPI 15095 | 150 | 0.9 | 5000 | | | CA | D706-12 | | | | | | | 1.34 | | | | | | | 250 | | | |
| SPI 16015 | 160 | 0.1 | 5000 | | 210 | MM | D788-4 | | | 12000 | | | | 1.20 | 0.07 | 0.06 | 0.04 | 4.0 | 4.0 | 3.0 | 400 | 350 | $10^8$ | |
| SPI 16025 | 160 | 0.2 | 5000 | | 210 | MM | D788-2 | | | 12000 | | | | 1.20 | 0.07 | 0.06 | 0.04 | 4.0 | 4.0 | 3.0 | 400 | 350 | $10^8$ | |
| SPI 16056 | 160 | 0.5 | 6000 | | 210 | CA | D706-5 | | | 9000 | | | | 1.37 | | | | | | | 250 | | | |
| SPI 16069 | 160 | 0.6 | 9000 | | 380 | PA | D789 | | | | | | | 1.15 | | | | | | | 350 | | | |

# PLASTICS INDUSTRY
# TIC MOLDING MATERIALS

## NATION READ SCOPE)

UIREMENTS ADDED BY SUFFIX LETTERS

| ELECTRICAL PROPERTIES | | | | | | | | OPTICAL PROP. | | | THERMAL PROP. | | CHEM. PROP. | AGING | PROP. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dielectric Constant ASTM D150-42T | | | Dielectric Strength Volts per Mil ASTM | D149-44T | Volume Resistivity Meg-Ohms CM | Resistance Insulation Meg-Ohms | Resistance Arc Sec. | Index of Refraction | Light Trans. % | Haze % | Coefficient of Thermal Expansion Linear in/in/°C x10⁻⁵ | Rate of Burning | Water Absorption % Net Gain | Weight Loss % | Dimension Change % | GRADE NUMBER |
| Cycles | | | Short Time | Step by Step | ASTM D257-38 | ASTM D257-38 | ASTM D495-42T | ASTM D542-43T | ASTM D672-43T | ASTM D672-45T | (9) | ASTM D635 | ASTM D570-42T | (11) | (12) | |
| 60 | $10^3$ | $10^6$ | | | | | | | | | | | | | | |
| MAX. | MAX. | MAX. | MIN. | MIN. | MIN. | MIN. | MIN. | MIN. | MIN. | MAX. | MAX. | MAX. | MAX. | MAX. | MAX. | |
| Bd | Be | Bf | Eg | Eh | Ei | Ej | Ek | Oa | Ob | Oc | Ta | Tb | Ca | As | Ab | |
| | | | 250 | | | | | 1.46 | 80 | | | | 1.60 | 2.4 | | SPI 10232 |
| | | | 250 | | | | | | | | | | 1.30 | 6.0 | | SPI 10252 |
| | | | 250 | | | | | | | | | | 4.50 | 11.3 | | SPI 10302 |
| | | | 250 | | | | | 1.46 | 80 | | | | 1.50 | 3.0 | | SPI 10311 |
| | | | | | | | | | | | | | | | | |
| | | | 250 | | | | | | | | | | 2.90 | 7.5 | | SPI 11172 |
| | | | 250 | | | | | | | | | | 1.30 | 4.5 | | SPI 11173 |
| | | | 250 | | | | | | | | | | 1.70 | 2.0 | | SPI 11182 |
| | | | 250 | | | | | | | | | | 1.90 | 7.0 | | SPI 11203 |
| | | | 250 | | | | | | | | | | 4.30 | 9.3 | | SPI 11223 |
| 4.0 | 3.8 | 3.7 | 350 | | | | | | | | | | 1.60 | 2.0 | | SPI 11304 |
| | | | 250 | | | | | | | | | | 1.70 | 1.4 | | SPI 11504 |
| | | | | | | | | 1.46 | 80 | | | | | | | |
| | | | | | $10^8$ | | | | | | | (13) | 0.15 | | | SPI 12027 |
| | | | | | $10^8$ | | | | | | | (13) | 0.15 | | | SPI 12034 |
| | | | 250 | | | | | | | | | | 1.50 | 1.9 | | SPI 12104 |
| | | | 250 | | | | | | | | | | 1.40 | 3.0 | | SPI 12123 |
| | | | 250 | | | | | | | | | | 3.10 | 5.5 | | SPI 12133 |
| | | | 250 | | | | | | | | | | 2.10 | 4.3 | | SPI 12144 |
| | | | 250 | | | | | | | | | | 1.80 | 1.5 | | SPI 12153 |
| | | | 250 | | | | | | | | | | 3.00 | 5.6 | | SPI 12174 |
| | | | 250 | | | | | | | | | | 3.50 | 7.1 | | SPI 12193 |
| 4.0 | 3.8 | 3.7 | 350 | | | | | | | | | | 1.60 | 1.40 | | SPI 12355 |
| | | | 250 | | | | | | | | | | 1.70 | 0.80 | | SPI 12505 |
| | | | | | | | | | | | | | | | | |
| 4.0 | 4.0 | 3.0 | 400 | 350 | $10^8$ | | | 1.48 | 90 | | | | 0.50 | NONE | | SPI 13015 |
| 4.0 | 4.0 | 3.0 | 400 | 350 | $10^8$ | | | 1.48 | 90 | | | | 0.50 | NONE | | SPI 13025 |
| | | | | | $10^8$ | | | | | | | (13) | 0.15 | | | SPI 13035 |
| | | | 250 | | | | | 1.46 | 80 | | | | 2.80 | 4.5 | | SPI 13104 |
| | | | 250 | | | | | | | | | | 1.90 | 0.8 | | SPI 13104-2 |
| | | | 350 | | | | | | | | | | 1.70 | 0.8 | | SPI 13355 |
| | | | 250 | | | | | | | | | | 1.70 | 0.2 | | SPI 13505 |
| | | | | | | | | | | | | | | | | |
| | | | 250 | | | | | 1.46 | 80 | | | | 3.50 | 3.0 | | SPI 14085 |
| | | | 250 | | | | | 1.46 | 80 | | | | 4.40 | 3.0 | | SPI 14085-2 |
| | | | 250 | | | | | | | | | | 2.40 | 2.5 | | SPI 14115 |
| | | | 350 | | | | | | | | | | 1.70 | 0.2 | | SPI 14256 |
| | | | | | | | | | | | | | | | | |
| 5.1 | 4.2 | 3.3 | 350 | 300 | $10^8$ | | | | | | | (13) | 0.10 | 2.0 | | SPI 15054 |
| | | | 250 | | | | | 1.46 | 80 | | | | 4.70 | 2.0 | | SPI 15055 |
| | | | 250 | | | | | | | | | | 2.10 | 0.4 | | SPI 15065 |
| | | | 250 | | | | | | | | | | 2.70 | 1.6 | | SPI 15095 |
| | | | | | | | | | | | | | | | | |
| 4.0 | 4.0 | 3.0 | 400 | 350 | $10^8$ | | | 1.48 | 90 | | | | 0.50 | NONE | | SPI 16015 |
| 4.0 | 4.0 | 3.0 | 400 | 350 | $10^8$ | | | 1.48 | 90 | | | | 0.50 | NONE | | SPI 16025 |
| | | | 250 | | | | | 1.46 | 80 | | | | 4.70 | 1.1 | | SPI 16056 |
| | | | 350 | | | | | | | | | | 1.50 | | | SPI 16069 |

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPI 16015 | 160 | 0.1 | 5000 | | 210 | MM | D788-4 | | | 12000 | | | | 1.20 | 0.07 | 0.06 | 0.04 | 4.0 | 4.0 | 3.0 | 400 | 350 |
| SPI 16025 | 160 | 0.2 | 5000 | | 210 | MM | D788-2 | | | 12000 | | | | 1.20 | 0.07 | 0.06 | 0.04 | 4.0 | 4.0 | 3.0 | 400 | 350 |
| SPI 16056 | 160 | 0.5 | 6000 | | 210 | CA | D706-5 | | | 9000 | | | | 1.37 | | | | | | | 250 | |
| SPI 16069 | 160 | 0.6 | 9000 | | 380 | PA | D789 | | | | | | | 1.15 | | | | | | | 350 | |
| | | | | | | | | | | | | | | | | | | | | | | |
| SPI 17035 | 170 | 0.3 | 5000 | 150 | | $PS_1$ | D703-1 | | | 8000 | | | | 1.07 | 0.0006 | 0.0005 | 0.0010 | 2.75 | 2.75 | 2.75 | 450 | 400 |
| SPI 17035-2 | 170 | 0.3 | 5000 | 150 | | $PS_1$ | D703-2 | | | 8000 | | | | 1.07 | 0.0003 | 0.0003 | 0.0005 | 2.60 | 2.60 | 2.60 | 500 | 450 |
| | | | | | | | | | | | | | | | | | | | | | | |
| SPI 18023 | 180 | 0.2 | 3000 | | | $PS_2$ | D703-3 | | | 4000 | | | | 1.40 | 0.002 | 0.003 | 0.001 | 2.80 | 2.80 | 2.80 | 400 | 400 |
| | | | | | | | | | | | | | | | | | | | | | | |
| SPI 23036 | 230 | 0.3 | 6000 | 250 | | $PF_1$ | D700-1 | | | 11000 | 25000 | | | 1.30 | | | | | | | 300 | |
| | | | | | | | | | | | | | | | | | | | | | | |
| SPI 24035 | 240 | 0.3 | 5000 | 300 | | $PF_7$ | D700-7 | | | 8000 | 15000 | | | 2.00 | 0.050 | 0.030 | 0.020 | 6.0 | 5.5 | 5.0 | 350 | 300 |
| SPI 24035-2 | 240 | 0.3 | 5000 | 250 | | $PF_8$ | D700-8 | | | 8000 | 15000 | | | 2.00 | 0.025 | 0.020 | 0.010 | 6.0 | 5.5 | 5.0 | 350 | 300 |
| SPI 24085 | 240 | 0.8 | 5000 | 250 | | $PF_4$ | D700-4 | | | 9000 | 25000 | | | 1.45 | | | | | | | 200 | 75 |
| SPI 24176 | 240 | 1.7 | 6000 | 250 | | $PF_5$ | D700-5 | | | 9000 | 25000 | | | 1.45 | | | | | | | 200 | 75 |
| SPI 24406 | 240 | 4.0 | 6000 | 250 | | $PF_6$ | D700-6 | | | 9000 | 15000 | | | 1.45 | | | | | | | 200 | 50 |
| | | | | | | | | | | | | | | | | | | | | | | |
| SPI 26024 | 260 | 0.2 | 4000 | 350 | | $PF_{10}$ | D700-10 | | | 7500 | 15000 | | | 2.50 | | | | | | | 300 | 200 |
| SPI 26026 | 260 | 0.2 | 6000 | 300 | | $PF_2$ | D700-2 | | | 9000 | 25000 | | | 1.45 | | | | | | | 300 | 250 |
| SPI 26036 | 260 | 0.3 | 6000 | 300 | | $PF_3$ | D700-3 | | | 9000 | 25000 | | | 1.42 | | | | | | | 300 | 200 |
| SPI 26074 | 260 | 0.7 | 4000 | 400 | | $PF_9$ | D700-9 | | | 9000 | 15000 | | | 2.00 | | | | | | | 200 | 150 |
| | | | | | | | | | | | | | | | | | | | | | | |
| SPI 27025 | 270 | 0.2 | 5000 | 210 | | $MF_2$ | D704-2 | | | 7500 | 25000 | | | 2.20 | | | 0.06 | 8.0 | 7.3 | 6.7 | 300 | 250 |
| SPI 27026 | 270 | 0.2 | 6000 | 170 | | $UF_1$ | D705-1 | | | 10000 | 24000 | | | 1.55 | | | | | | | 300 | 250 |
| SPI 27026-2 | 270 | 0.2 | 6000 | 170 | | $UF_2$ | D705-2 | | | 10000 | 24000 | | | 1.55 | | | | | | | 300 | 250 |
| SPI 27026-3 | 270 | 0.2 | 6000 | 170 | | $UF_3$ | D705-3 | | | 10000 | 24000 | | | 1.55 | 0.10 | 0.06 | 0.04 | 9.5 | 9.0 | 7.5 | 300 | 250 |
| | | | | | | | | | | | | | | | | | | | | | | |
| SPI 30026 | 300 | 0.2 | 6000 | 210 | | $MF_1$ | D704-1 | | | 9000 | 25000 | | | 1.55 | 0.08 | 0.05 | 0.06 | 9.5 | 9.0 | 8.2 | 300 | 250 |

## HOW TO USE THE CHART

*Grade numbers:*

Grade numbers give a general description of the material. These grade numbers consist of five digits following the prefix letters SPI which stand for the Society of the Plastics Industry. The first two digits indicate the minimum heat distortion temperature using a flexural load of 264 lb. fiber stress (ASTM D 648-41T). For example, 10 stands for 100° F., 11 for 110° F., etc. The next two digits indicate the minimum impact strength [energy absorbed in ft. lb. per in. of notch, Izod (ASTM D 256)]. For example, 03 stands for 0.3 ft. lb., 10 for 1.0 ft. lb., etc. The last digit indicates the minimum tensile strength; (ASTM D 638-42T; D 638-44T; D 651-44T). In this case, 5 would indicate 5000 p.s.i. and 6 indicates 6000 p.s.i.; etc. Thus, according to the Classification, a grade number of SPI 10232 would express 100° F. heat distortion temperature, 2.3 ft. impact strength, and 2000 p.s.i. tensile strength. While the choice of heat distortion, impact and tensile as characterization properties is purely arbitrary, these properties are found in one form or another in practically all ASTM, Federal and Joint Army-Navy Plastics Specifications.

*Suffix letters:*

(1). The suffix shall be used to specify other properties in addition to those controlled by the grade numbers, i.e., properties such as mechanical, electrical, optical, thermal, chemical and aging which, jointly or severally, are unique to each application and are of vital importance to the design engineer. Capital letters M, E, O, T, C and A designate mechanical, electrical, optical, thermal, chemical and aging requirements, respectively. The small suffix letter following the capital letter indicates the specific desired value, for example, Ea for power factor at 60 cycles, Ed for dielectric constant at 60 cycles, Oa for refractive index, etc. (Refer to Note 1 for further explanation).

According to this systematic Classification, an SPI grade number followed by suffix letters designates both *basic requirements and other requirements added by suffix letters;* for example, SPI 10232-Eg means that the plastic shall have a minimum heat distortion temperature of 100° F., min. 2.3 ft. lb. per in. of notch impact strength, Izod, min. 2000 p.s.i. of tensile strength as *basic requirements.* The *requirement added by suffix* calls for a minimum 250 volts per mil, of dielectric strength, short-time test method.

If all of the electrical properties shown as suffix letters Ea, Eb, Ec, Ed, Ee, Ef, Eg, Eh, Ei, Ej and Ek are desired, the capital letter *E* is used by itself after the grade number. In this manner, the use of excess suffixes is avoided. The same procedure applies to other suffixes such as capital letters M, E, O, T, C, or A denoting all the mechanical, electrical, optical, thermal, chemical or aging properties. Finally, if all the *unique properties across the table after any particular SPI number* are desired, the letter Z is used in the fo manner: SPI 10232-Z. This suffix then indicates the unique properties are desirable in add those in the grade number.

(2). The grade numbers as shown in the tab from the top down with increasing heat-di temperature values using the 264 lb. fiber str Additional requirements covered by suffix let across the table starting with each respective SP number. If properties under the suffix letter are of primary interest and values controlled grade number are of secondary importance, th can be used in reverse manner, provided that th number and suffix or suffix letters are shown to For example, if a minimum power factor at 10 is required for an application, the user can tra the Ec column and find a value of 0.0005. down from right to left, the corresponding gr be SPI 17035-2. He can then specify SPI 170 on the part drawing. It is recommended that many suffix letters be selected as are required application. When there are two exact grad different properties in the suffix columns, on grade numbers will be followed by a hyphe For example, SPI 13104-2. Refer to the t further explanation.

Published in October 1945 issue of Modern Plastics Magazine

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.0 | 4.0 | 3.0 | 400 | 350 | $10^8$ | | | 1.48 | 90 | | | | 0.50 | NONE | | SPI 16015 |
| 4.0 | 4.0 | 3.0 | 400 | 350 | $10^8$ | | | 1.48 | 90 | | | | 0.50 | NONE | | SPI 16025 |
| | | | 250 | | | | | 1.46 | 80 | | | | 4.70 | 1.1 | | SPI 16056 |
| | | | 350 | | | | | | | | | | 1.50 | | | SPI 16069 |
| | | | | | | | | | | | | | | | | |
| 2.75 | 2.75 | 2.75 | 450 | 400 | $10^9$ | $10^4$ | 60 | 1.58 | 85 | 5.0 | | | 0.10 | 0.1 | | SPI 17035 |
| 2.60 | 2.60 | 2.60 | 500 | 450 | $10^{11}$ | $10^6$ | 60 | 1.58 | 85 | 5.0 | | | 0.10 | 0.1 | | SPI 17035-2 |
| | | | | | | | | | | | | | | | | |
| 2.80 | 2.80 | 2.80 | 400 | 400 | $3.5 \times 10^{13}$ | $10^6$ | 5 | | | | | | 0.10 | 0.1 | | SPI 18023 |
| | | | | | | | | | | | | | | | | |
| | | | 300 | | | 100 | | | | | | | 0.20 | | | SPI 23036 |
| | | | | | | | | | | | | | | | | |
| 6.0 | 5.5 | 5.0 | 350 | 300 | $10^6$ | 300 | | | | | | | 0.15 | | | SPI 24035 |
| 6.0 | 5.5 | 5.0 | 350 | 300 | $10^6$ | 300 | | | | | | | 0.07 | | | SPI 24035-2 |
| | | | 200 | 75 | | 100 | | | | | | | 1.50 | | | SPI 24085 |
| | | | 200 | 75 | | 100 | | | | | | | 1.75 | | | SPI 24176 |
| | | | 200 | 50 | | 100 | | | | | | | 1.75 | | | SPI 24406 |
| | | | | | | | | | | | | | | | | |
| | | | 300 | 200 | | 300 | | | | | | | 0.25 | | | SPI 26024 |
| | | | 300 | 250 | | 100 | | | | | | | 0.80 | | | SPI 26026 |
| | | | 300 | 200 | | 100 | | | | | | | 1.00 | | | SPI 26036 |
| | | | 200 | 150 | | 300 | | | | | | | 0.25 | | | SPI 26074 |
| | | | | | | | | | | | | | | | | |
| 8.0 | 7.3 | 6.7 | 300 | 250 | | | 120 | | | | | | 0.15 | | | SPI 27025 |
| | | | 300 | 250 | | | | | | | | | 3.00 | | | SPI 27026 |
| | | | 300 | 250 | | | | | | | | | 3.00 | | | SPI 27026-2 |
| 9.5 | 9.0 | 7.5 | 300 | 250 | $10^6$ | | 90 | | | | | | 3.00 | | | SPI 27026-3 |
| | | | | | | | | | | | | | | | | |
| 9.5 | 9.0 | 8.2 | 300 | 250 | | | 80 | | | | | | 1.80 | | | SPI 30026 |

*cross the table after any particular SPI grade* are desired, the letter Z is used in the following SPI 10232-Z. This suffix then indicates that all que properties are desirable in addition to the grade number.

he grade numbers as shown in the table read e top down with increasing heat-distortion ature values using the 264 lb. fiber stress test. nal requirements covered by suffix letters run he table starting with each respective SPI grade . If properties under the suffix letter columns primary interest and values controlled by the umber are of secondary importance, the table sed in reverse manner, provided that the grade and suffix or suffix letters are shown together. mple, if a minimum power factor at $10^6$ cycles red for an application, the user can trace down column and find a value of 0.0005. Reading om right to left, the corresponding grade will 17035-2. He can then specify SPI 17035-2-Ec part drawing. It is recommended that only as ffix letters be selected as are required for the tion. When there are two exact grades with t properties in the suffix columns, one of the umbers will be followed by a hyphen 2 (-2). mple, SPI 13104-2. Refer to the table for explanation.

lastics Magazine

SPECIAL NOTE:

Values shown in the table were determined in most cases by using ASTM Test Methods. Property values of molded parts may be higher or lower since the design and molding conditions have an important bearing on the final properties. It is essential that reference be made to the chapters on "Parts Design Criteria" and "Molding and Forming of Plastics Parts" in the SPI Handbook.

NOTE (1): Code for Materials

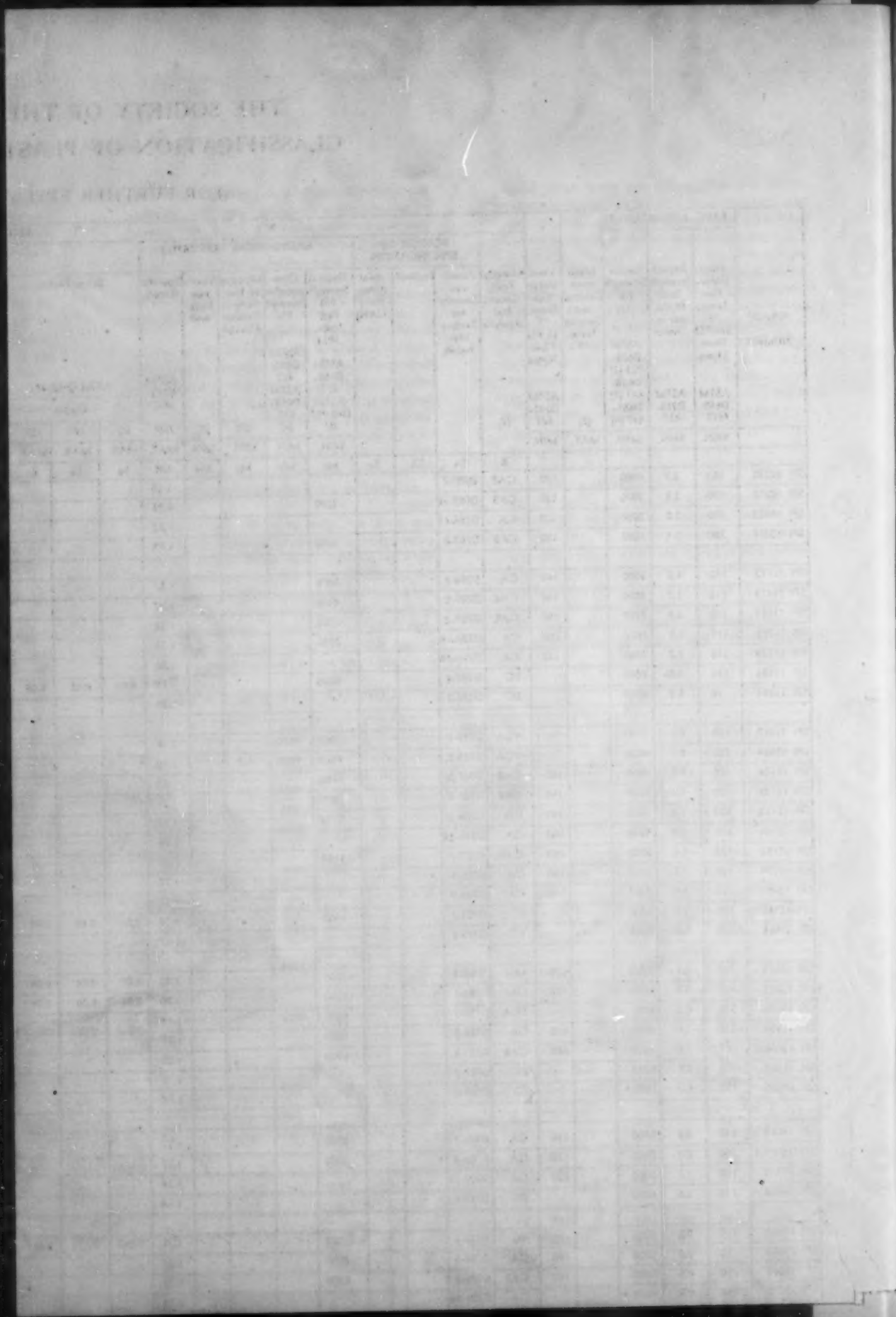
THERMOPLASTIC

| | | | |
|---|---|---|---|
| CA | Cellulose Acetate | $PS_1$ | Polystyrene |
| CAB | Cellulose Acetate Butyrate | $PS_2$ | Polystyrene |
| EC | Ethyl Cellulose | VC | Vinylidene Chloride |
| MM | Methyl Methacrylate | VCA | Vinyl Chloride Acetate |
| PA | Polyamide | | |

THERMOSETTING

| | | | |
|---|---|---|---|
| $MF_1$ | Melamine Formaldehyde | $PF_7$ | Phenol Formaldehyde |
| $MF_2$ | Melamine Formaldehyde | $PF_8$ | Phenol Formaldehyde |
| $PF_1$ | Phenol Formaldehyde | $PF_9$ | Phenol Formaldehyde |
| $PF_2$ | Phenol Formaldehyde | $PF_{10}$ | Phenol Formaldehyde |
| $PF_3$ | Phenol Formaldehyde | $UF_1$ | Urea Formaldehyde |
| $PF_4$ | Phenol Formaldehyde | $UF_2$ | Urea Formaldehyde |
| $PF_5$ | Phenol Formaldehyde | $UF_3$ | Urea Formaldehyde |
| $PF_6$ | Phenol Formaldehyde | | |

NOTES (2) through (13): This information is contained in the complete description of the chart (The Scope) which can be obtained from the Society of the Plastics Industry.



PLASTICS*
Engineering Section
F. B. STANLEY, Editor

# Heating cylinders

by ISLYN THOMAS†

***The heating cylinder, which has been termed the most important element of an injection molding machine, was introduced in 1872 in a method of extrusion developed to meet the need for processing cellulose nitrate. This unit did not, however, have so profound an effect on injection molding as the introduction of the Gastrow cylinder which was patented in Germany in 1932 and in America in 1936. The most unique feature of this Gastrow cylinder was the pineapple, or spreader, which forced the plastic granules into a thin layer. American heaters, while patterned after this Gastrow unit, are made with straight rather than diverging entrances and they do not employ a heating element in the pineapple or spreader***

THE heating cylinder, sometimes called the heart of the injection machine, is the unit which melts or plasticizes the molding material just before it is introduced into the mold. Since it is the most important element of an injection molding machine, its development is closely allied with the history of injection molding which lists 1872 and 1936, or perhaps 1934, as the two most important dates. The uncertainty in the last two dates will be explained later on in this article.

The year 1872 marks the granting of a patent to John Wesley Hyatt for his Celluloid material. A method of extrusion, which was developed to meet the need for processing this material, introduced a heating cylinder of very simple design with basic features that characterize present-day units. However, because of the high flammability of cellulose nitrate this extrusion process was not exploited. As a result, in spite of its importance, the heating cylinder used in this extruder did not have so profound an effect upon injection molding as the developments of 1934.

Thus, the introduction into the United States in 1934 of a commercial thermoplastic injection machine with an improved type heating cylinder really spearheaded the development of American injection machines. Except for the heating cylinder, the machine was very similar to the die casting unit which had already been extensively developed. This Hans Gastrow heating cylinder on which German patents were issued on December 10, 1932, started the mushrooming of the American plastics injection machine. Although a patent was applied for in the United States in 1933 and although it was introduced here in 1934, the American patent was not issued until 1936—a lag which explains the uncertainty as to which date—1934 or 1936—should be listed as a milestone.

## The Gastrow heating cylinder

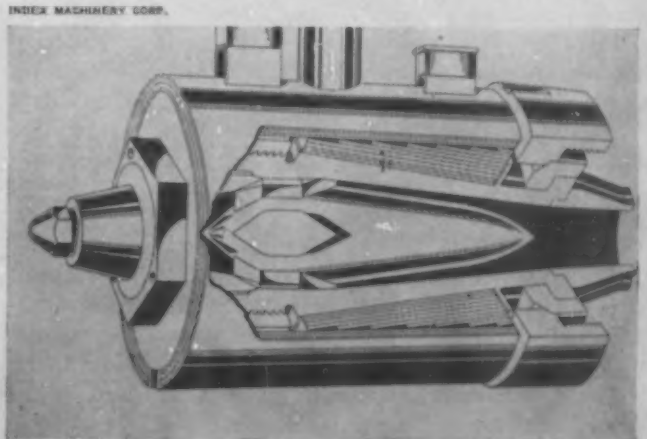
The Gastrow cylinder (Patent 2,057,945) was unique in that it contained a pineapple, or spreader, as it is sometimes called, which forced the plastic granules into a thin layer between itself and the wall of the heating cylinder. This gave the machine a large heating surface area in relation to the volume of the cylinder.

Because of the poor thermal conductivity of plastics the material had to be forced into thin layers since the heat would not penetrate heavy sections fast enough. However, as the material became plasticized a change in volume took place. In the granulated state, 1 oz. of plastic occupies 3.3 cu. in.; in the plasticized state the same ounce takes up only 1.33 cu. inches. In the Gastrow design this change was compensated for by a reduction in the surface area of the heating cylinder toward the nozzle. The pineapple, or spreader, is still designed in this way but the reduction is not so marked as was believed necessary in 1936.

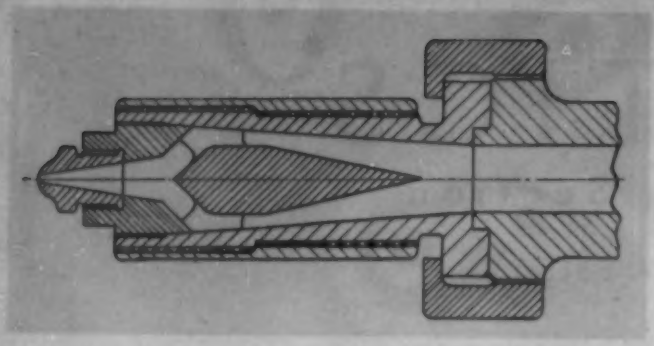
The Gastrow cylinder (Fig. 1) was constructed with mathematical precision to obtain this reduction in volume and, at the same time, maintain a large surface area. In a sense, this proved to be the weak point in the patent. As can be seen in

***1—The Gastrow heating cylinder which was first patented in Germany in 1932, then in America in 1936, contained a pineapple which forced the plastic granules into a thin layer between itself and the wall of the cylinder***

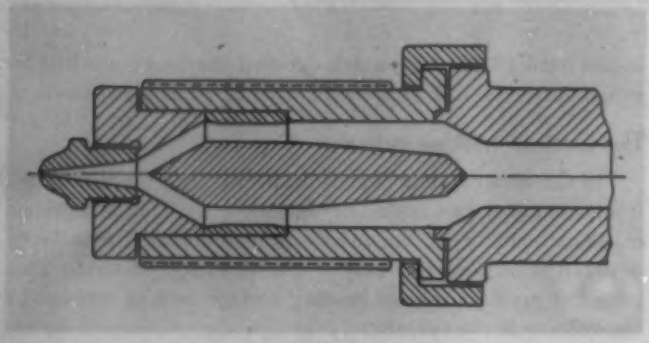
INDEX MACHINERY CORP.



* Reg. U. S. Patent Office.
† President, Thomas Manufacturing Corp.



*2—The general details of the Gastrow heating cylinder are clearly defined in this drawing. As can be seen, the pineapple, or spreader, changes in dimensions to accommodate changes in the diameter of the heating chamber*



*3—This early American heater, which sets the pattern for most of our modern heating cylinders, is constructed so that an integral ring takes the place of fins on the pineapple. This design of the spreader simplified production and tended to eliminate the danger of material being trapped in the heating cylinder and burning*

Fig. 2, the material enters the heater and is immediately forced against diverging walls by the pineapple, or spreader. The pineapple changes in dimensions to accommodate the increase in the diameter of the heating chamber and to reduce the volume as the material proceeds to the nozzle. The heater converges very rapidly again to blend into the nozzle.

The Gastrow patent is tied up quite closely with the initial diverging section. Since American heaters were made with straight entrances, they did not infringe. The straight entrance had the further advantage of allowing more material to enter the heater. The Gastrow design, although theoretically correct, limited the volume of the heater which never handled much more than $1^1/_4$ oz. of material per shot.

There were other claims in the Gastrow patent that have not been used in America because of infringement—a heating element in the pineapple, or spreader, for example. To date the lack of this heater has not been a great obstacle, but there is a rumor that a commercial heater will be introduced with such an element.

## The first American heaters

The early American heaters were simple affairs patterned after the Gastrow unit. The pineapple, as it was still called, was small and the design was such that it could be removed with ease. This feature simplified the cleaning of the cylinder.

There were certain technical problems involved in the development of these early pineapples. The first of these spreaders was made with fins which had to be carefully lapped to insure a good fit against the wall of the heater. This was a difficult production job, and accuracy was lost after a short time. A loose fit with the walls of the heater meant that material would stick in the loose joints and burn. Eventually this burnt material worked loose and caused black streaks in the molding. It became advisable, therefore, to redesign the basic structure of the heater.

A pineapple was designed with an integral ring to take the place of fins. This ring contained holes to allow passage of the material. The pineapple was held in place by this flange section which, because of its flat surface, was easy to machine accurately. This design tended to eliminate the danger of trapped material in the heater. Figure 3 shows this construction. Almost all modern heating cylinders have followed this basic design.

The years from 1936 to 1938 saw only moderate improvement in the capacities of the heaters. In 1938, however, patents were granted to two individuals for somewhat radical changes in heater design.

## Steam cylinders

Patent 2,115,940 was granted to Arthur Burry in 1938 for a heating cylinder which used steam for the heating medium. The primary purpose of this design was to provide a means of heating the plastics in the heater so that wide temperature fluctuations did not occur. This was accomplished by building a jacket about the heater and filling it with steam generated with electrical resistance units. A steam pressure of 200 to 300 p.s.i. was required to furnish sufficient heat to plasticize the material.

Improvements in the design of standard heaters removed the fluctuation formerly present in resistance-type heater. This reduced, to a certain degree, the importance of the steam cylinder.

## Two-stage heater

The second radical change was introduced by Victor S. Shaw in Patent 2,107,190 assigned to The Hydraulic Press Corporation. This patent covered the design of a complete injection machine. The heater used on this machine is outstanding for two reasons: first, because it introduced a two-stage heater; second, because it used circulated heated oil for the heating medium.

The two-stage unit (shown in Fig. 4) is essentially two separate heating units. A preheater unit receives the fresh charge of plastic. This material is partially plasticized and injected into a second, much smaller, heater. Then, a second plunger forces the partially plasticized material through this second heater and into the dies.

Primarily, this device provided a small high-pressure injection plunger, a short stroke made possible further economies in the high-pressure injection plunger and actuating parts. The initial charging or preheating cylinder used a long stroke but low pressure parts. Another advantage was the theoretical reduction in friction loss on the injected material due to the short high-pressure stroke. However, despite the theoretical gains in efficiency, the device was rather cumbersome and was discontinued.

The oil-circulating system of heating is still in use, providing the heater with more uniform heat just like the steam cylinder. By controlling the circulation of the oil from the front to the rear of the heater, a certain amount of "zone" temperature control was provided in this unit. However, the oil lacked the simple flexibility of resistance bands which could be changed in wattage to provide different zones of heat.

## Magnetic heaters

In 1938 and 1939, a few years before the commercial advent of the radio-frequency heating units, there was brought into use a heating chamber which utilized means other than electric resistance bands for heating.

One injection machine manufacturer introduced commercially a unit called the magnetic heater. Low-frequency—50 to 60 cycle—currents were passed through coils of wire that surrounded the steel body of the heating cylinder. The magnetic fields set up by this action caused the steel body to become heated and this heat was transferred to the plastic material inside.

The low-frequency currents were eminently satisfactory for this application. Thus, a unit was developed which could be plugged directly into the wiring circuit. While control of the temperature was exceptionally good in this heater, the primary feature related to the speed of heating. In the space of 10 to 15 min. the heater was ready to operate. Previous resistance band heaters required from 30 to 40 min. to come up to the proper heat.

## Effect of radio-frequency

The fate of this heater may indicate the effects radio-frequency heating will have on injection machines. The magnetic unit is no longer used. Simple, easy-to-understand and inexpensive electrical resistance has taken its place. Temperature regulation is now sufficiently sensitive, and the advantage of coming up to heat quickly is only of importance when the machine is started up at the beginning of a shift. With continuous operation, little time is lost waiting for the heat to come up.

If quick raising of the heat is of minor importance, then it follows that radio-frequency heating, which has this feature as a prime advantage, may not become so important a development in injection as it has in compression molding. A possible exception will be discussed later on in this article.

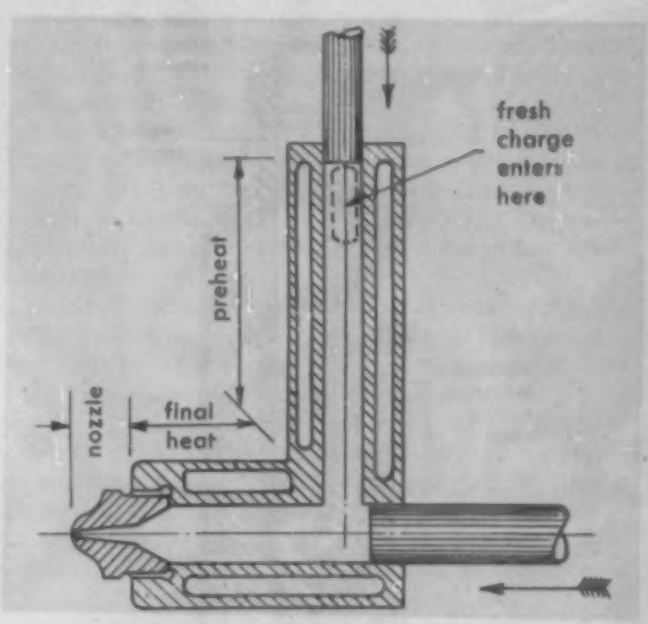
## The modern heater

A brief review of the history brings us to the modern heater design. Figures 5 and 6 show a heater of this type, the basic features of which are present in similar forms in almost all competitive heater designs.

*Heating media*—Electrical resistance bands are used throughout these units, three zones of heat usually being provided. One manufacturer controls temperature with three thermocouples; another with two thermocouples and provision for variable wattage for the nozzle zone.

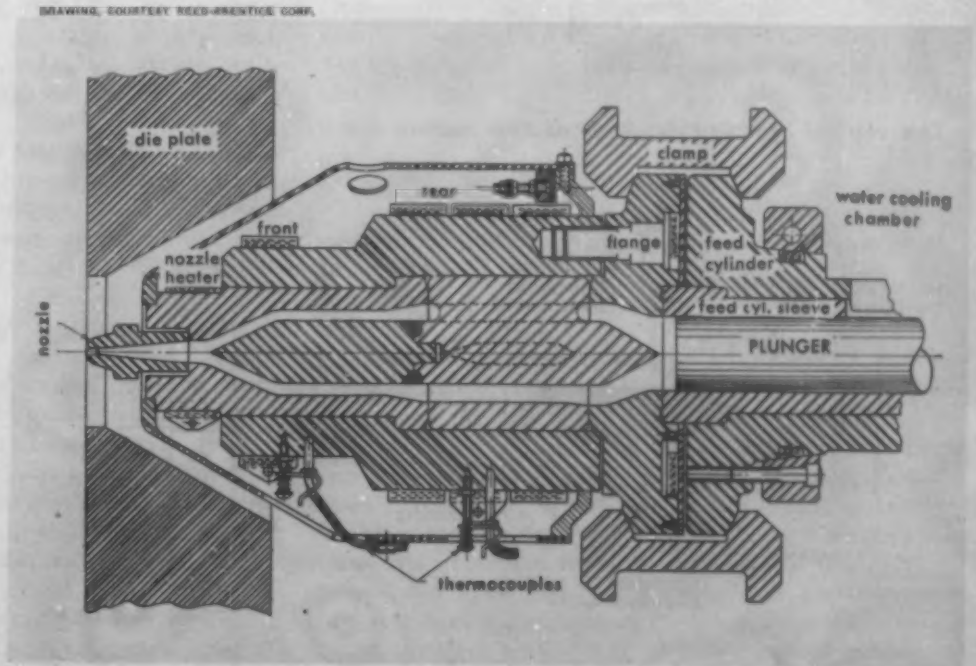
In some designs it is desirable to have extra bands of different wattage to control surges of temperature. This is particularly true when the wall of the heater body is quite thin. In designs with a heavy wall section the surges are taken care of by the steel section and interchange of bands is unnecessary. The danger of this is that the control will be too sluggish as in the oil-circulating and steam systems. There is a desirable balance between the extremes of too much damping and too much fluctuation and this is achieved in modern designs.

(*Please turn to next page*)




***4—This two-stage heating cylinder is essentially two separate units, the preheater receiving the fresh charge of plastic material and passing it on after partial plasticization to the second—the injection—cylinder***

DRAWING, COURTESY REED-PRENTICE CORP.



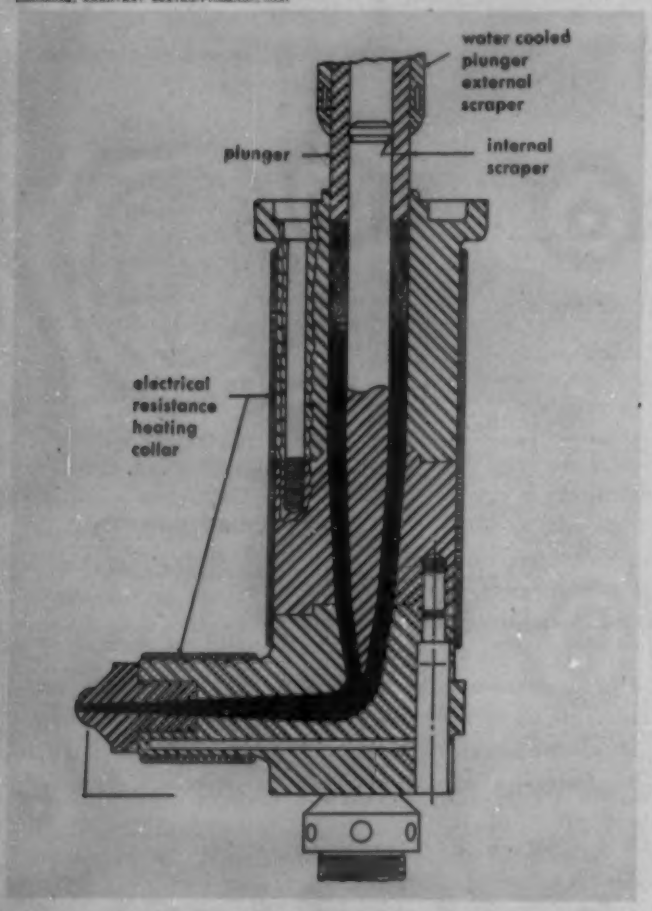

***5—The basic features of this new type resistance heating cylinder demonstrate the latest advances which have been made in this type of unit***

*The spreader, or pineapple*—This element consists of a flanged section which contains holes or slots for the passage of the plastic. The flange is designed with flat surfaces which are very simple to machine and to lap to a close fit. In fact, the development of flat surfaces for contact is responsible for the greatly improved operation of the heaters.

The spreader shown in Fig. 5 is located so that the cold material must separate in order to pass through the flanged section. In this design the forward end, where the material is thoroughly plasticized, is entirely free of obstructions and does not have joints that might become loose and allow material to enter. The spreader is also arranged with the flange in the direction of the nozzle to insure further against the possibility of looseness. However, there will be the advantage of introducing the cold material with less friction than when it is necessary to force it through the flange section.

As mentioned previously, one feature of the Gastrow heating cylinder patent which has not been developed commercially up to this time, is the electric heating element in the core of the spreader. Such a unit would give additional heat to speed the process of plasticizing the material during its passage through the heater. However, a number of difficulties are involved in providing the mechanical equipment for such an internal heater. At any rate, spreaders are designed without the internal heater and apparently do not suffer seriously from this lack. Of course, the magnetic heater did generate a small amount of heat in the core. Present-day spreaders transmit heat through the heavy sections of the flange.

DRAWING, COURTESY LESTER-PHOENIX, INC.




**6**—*This vertical heating cylinder is another modern unit*

## Special features

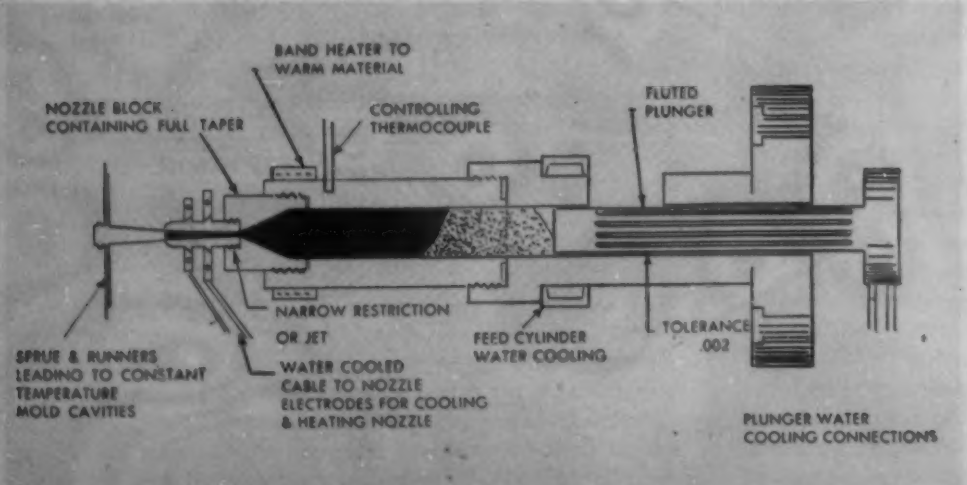
*Chrome plating* was introduced in 1938 and 1939 primarily to protect the heater from the action of the acids released when vinyl materials were overheated. Although plating proved quite satisfactory, there was always the danger that it would peel off or that it would not cover the sharp corners and thus leave exposed a spot where the acids could begin their work.

*Stainless steel* construction, now standard for at least one manufacturer, offers greatly increased resistance to the acids present in wartime materials. It is not, however, guaranteed to resist the acids of the vinyl and it cannot be used for vinylidene chloride or Saran, which cannot be used with any ferrous metal in the hot zone.

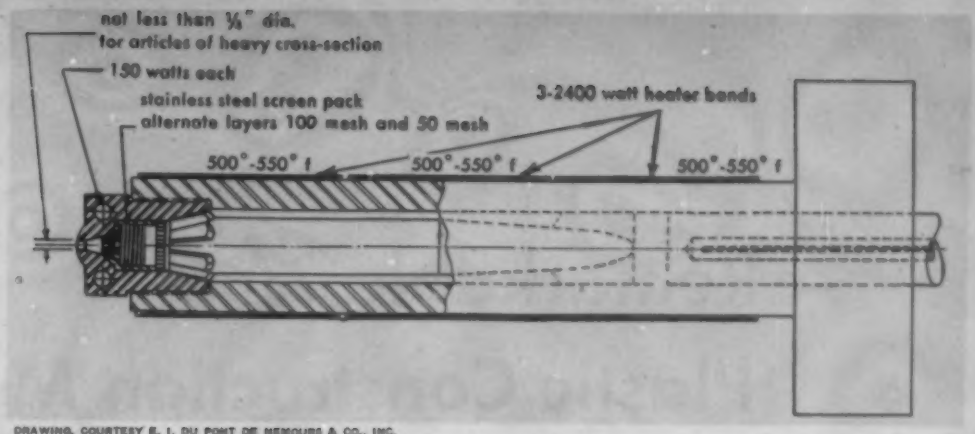
*Hastelloy forging inserts* are used in special heaters to provide the optimum in protection. Heaters of this construction are approximately three times as expensive but are almost indestructible from acid erosion. This type is recommended for Saran, and is desirable for the vinyl, although a stainless steel unit can be used with this latter material if great care in molding is taken.

## Special heaters

*Jet molding heaters*—These heaters are among the units that may be further developed for use in standard heaters. Primarily they were developed for the continuous injection molding of thermosetting materials. As shown in Fig. 7, the heater is made up of two sections and does not contain a spreader. The first section is a simple cylinder which acts as a preheater. The front or nozzle section has a very small


BAND HEATER TO WARM MATERIAL
NOZZLE BLOCK CONTAINING FULL TAPER
CONTROLLING THERMOCOUPLE
FLUTED PLUNGER
NARROW RESTRICTION OR JET
FEED CYLINDER WATER COOLING
TOLERANCE .002
SPRUE & RUNNERS LEADING TO CONSTANT TEMPERATURE MOLD CAVITIES
WATER COOLED CABLE TO NOZZLE ELECTRODES FOR COOLING & HEATING NOZZLE
PLUNGER WATER COOLING CONNECTIONS

**7**—*In jet molding the heater is designed so that substantially all heat necessary for polymerization is added in the nozzle of the heating unit*




DRAWING, COURTESY E. I. DU PONT DE NEMOURS & CO., INC.

*8—The unusual feature about this nylon heater is the special nozzle which is equipped with screens and an extra heating unit*

hole through which the preheated material is forced. As the material passes through this nozzle intense heat is supplied and, because of the small cross section, the plastic picks up this heat very rapidly. Only the material that enters the nozzle becomes heated to the plastic stage; the bulk of the material remains at a low temperature. This arrangement has definite advantages for materials that are adversely affected by a long exposure to high heat.

*Nylon heater*—The only unusual feature about this unit is the special nozzle which is equipped with screens and a small extra heating unit as shown in Fig. 8. Nylon has the characteristic of flowing like molten metal when it reaches its flow temperature. This is in contrast to most other thermoplastics which merely become soft enough to flow like tar under pressure and temperature. Because of this fluidity and because of the narrow temperature range, means must be provided to keep the nylon from oozing out of the nozzle between cycles. Valves can be used for this purpose, but they are not the simplest solution. The screens not only serve to retard the oozing of the liquid nylon but prevent the passage of large unplasticized particles. The heater must be capable of generating the higher heats required in molding of nylon.

*Radio-frequency heater*—A heater of this type is not yet a reality, but there is much speculation concerning the use of radio frequency on injection machines. As was explained in the description of the magnetic heater, there is little to indicate that use of radio frequency would be especially advantageous. This type of heat has served to speed up the molding of compression parts because it reduced the time required to introduce heat in the material. Because the injection process is continuous, this reduction is not of great significance.

There is, however, one possibility that may bring about the use of radio-frequency heat. But to appreciate this reason it is necessary to understand the process of injection molding. Whereas, the common plastic material will become plastic at a temperature of less than 300° F., the temperature control of the heater is set for 400° F. and higher because of the speed of molding. As long as the molding cycle is not interrupted, this temperature causes no damage. However, when the cycle is slowed or stopped, the material in the heater becomes overheated. In some cases this overheating merely scorches a small amount of material. But should the delay be of longer duration, a considerable amount of material may be burned and acids may be released by decomposition which will start to corrode the heater.

It may be desirable to design a heater that will hold only a small charge of material which is brought to heat rapidly by radio frequency. Then, in the event of cycle interruption, no further heat will be generated. For the complete success of such a unit there must also be a means of preventing the metal in the cylinder from storing heat which could burn the material during a lag in the cycle even though the heat generating medium be shut off.

A second advantage of such a unit would be that heat-sensitive materials would not be exposed to a long period of heating. The possibility of obtaining clear-cut superiority for both of these advantages is doubtful and therefore the development expense involved for such a design may not be worth while.

A number of schemes have been evolved and several patent applications are now pending which would use high-frequency currents to heat the plastics in an injection machine. One idea is to insulate the "torpedo" and connect it to a high-frequency generator in such a way that there is potential between the "torpedo" and the outer jacket. As the plastic passes through this space, the high-frequency currents heat it directly. The layer of plastic could be made quite thick so that more material could be heated in a heater with the same outside dimensions than would be possible by conventional methods. The chief problem in developing such a device would be the insulating of the "torpedo" with materials which have good electrical insulating properties and at the same time have adequate mechanical strength to withstand the high pressures used in an injection molding machine.

Other designs involve the elimination of the "torpedo" and the breaking up of the jacket into insulated sections to be used as electrodes. Still another approach is to heat the molding powder at a relatively low pressure and then push it through the nozzle at a higher pressure. It is an open secret that the leading manufacturers of injection presses are right now experimenting with electronic heating.

## Then and now

Although it may seem that the development of heaters went around in circles, the present-day heater is vastly superior to earlier models. The years prior to 1940 were fraught with changes. Almost every six months saw an improvement.

The present-day heater is designed with plenty of steel to give resistance to fatigue breakdown and to reduce fluctuations present in the electric resistance type of heating. A good balance has been achieved in the wattage for the heating elements. Stainless steel gives increased resistance to acid erosion. Improved design of spreaders present smoothly streamlined interiors.

Relatively inexpensive heaters, trouble-free temperature controls and units that accommodate color and material changes without dismantling are the benefits that the modern injection machine heating cylinder presents to the molder.

# A Remarkable *New* Plastic Construction Material

A newly-developed, low-pressure Plaskon laminating resin has made possible a revolutionary plastic engineering material:

> *a "sandwich" of parallel laminates of Plaskon resin and glass cloth, separated by and bonded to a feather-weight "honeycomb" core made of the same resin reinforced by glass cloth.*

This revolutionary material already has been proved in the construction of a complete airplane fuselage section, under the auspices of the ATSC aircraft laboratory at Wright Field, Ohio. It is the first time a representative structural airplane part has been fabricated with all-laminate sandwich construction, including core material.

This "honeycomb" glass cloth and Plaskon Resin all-laminate construction has an exceptional strength-weight ratio, smooth exterior surface, and extreme stiffness. It offers a great range of possibilities in the aircraft, automotive, construction and other fields requiring the fabrication of structural materials.

Other advantages include the possibility of prefabricating various "honeycomb" glass cloth parts in widely separated plants; the feasibility of mass production; the consistent uniformity of results; the ease and soundness of repairs; and the ready availability of raw materials.

Plaskon advancements in resin have made possible many revolutionary developments for industry and the individual. Plaskon resin research and experience may be of valuable assistance in your manufacturing and sales programs—ask for their help.

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**PLASKON DIVISION**

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In Canada: Canadian Industries, Ltd., Montreal, P. Q.

Half-mold of fuselage section with outer skin, half of rear bulkhead preform, "honeycomb" core, and tubular higher density core in place.

Completed fuselage section with two half portions welded into single unit by final molding operation.

# Plastics and petroleum work together

by STANLEY R. O'DETTE and RALPH E. O'DETTE*

***This is the first of a series of articles, which will be published in the Engineering Section of this magazine at intervals throughout the coming year, on petroleum as it relates to the equipment used in the manufacture of resins and to the machinery employed in the processing of these resins into finished products.***

***Too often, petroleum is looked upon by plant operating managers as a unavoidable expense rather than as a preventive maintenance material that greatly influences continuity of equipment service and overall operating costs. These articles will take the form of actual studies made in molding, fabricating and material production plants. They will include a description of the recommendations made to the management and a report on the improved performance resulting from these suggested changes.***

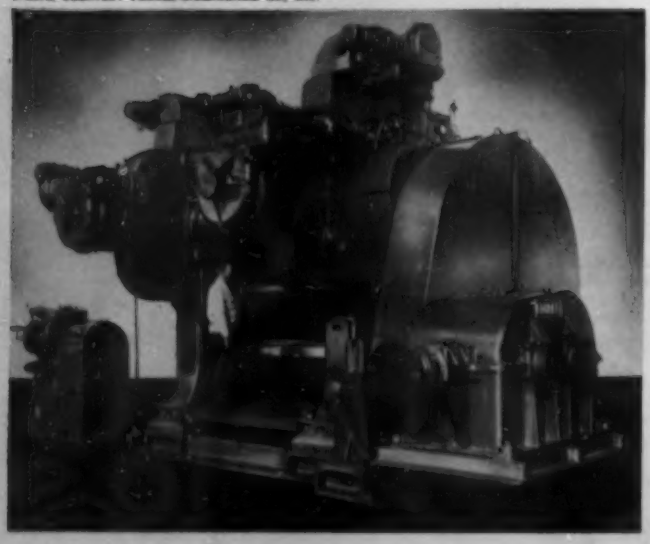
PLASTICS and petroleum are two industries that contribute materially to our industrial progress, again which, in peacetime, is immediately reflected in increased personal comforts and conveniences for the public. Both industries have made great strides, especially during the past few years.

Improvements in process and machinery design, and in operating techniques in the plastics industry have to a great extent made obsolete the old conception of petroleum as a limitation to plant efficiency. And the advances that have been made by the petroleum industry have removed many of the remaining limitations. Because of the unavoidable time lag in conveying to the plastics industry the knowledge of the improved performance that is now possible through newer and more suitable petroleum products, machinery is still being operated at repair or maintenance cycles that are prohibitive from the standpoint of repair costs and production interruptions.

* Standard Oil Company of New Jersey.

***The lubricants used in machines such as this calender, designed for double coating and multi-pass sheeting of rubber and plastics stock, have a marked effect on the continuity of operation and the overall operating costs***

PHOTO, COURTESY FARREL-BIRMINGHAM CO., INC.



To cover the subject of petroleum usage in the plastics industry and to make this coverage specific enough so that it will be immediately useful, it is necessary for us to limit our subject. In this series we shall deal with the equipment used in the manufacture of resins and with the machinery employed in the fabrication of these resins into finished products. To take up the production of basic raw materials, such as esters and monomeric hydrocarbons, would involve a consideration of practically all types of mechanical equipment.

These articles, which will appear at intervals throughout the year, will deal in detail with petroleum as a lubricant, hydraulic fluid, heat exchange medium, and a process material. Petroleum process materials such as solvents, plasticizers, asphalts and resins usually complement or serve as an adjunct to the preparation and fabrication of plastics commodities. It is hoped that, as this survey of the plastics industry progresses, plant operating managers cooperating in this work will offer suggestions as to the type of information they desire on the better utilization of petroleum.

## The role of petroleum

Throughout, the text will stress economies that can be achieved when petroleum lubricants are viewed in the light of their true relation to operating costs. At one extreme we often encounter the belief that oil of any quality and of suitable viscosity is satisfactory for all classes of service. At the opposite end of the scale we find that petroleum is expected to accomplish the incredible.

Petroleum should not be considered as an unavoidable expense, but rather as a preventive maintenance material that greatly influences continuity of equipment service. Relegating the actual application of lubricants to workmen of lesser skill and ability invariably proves to be costly.

Lubricants used in mechanical processing equipment affect not only the continuity of unit operation but, to an important degree, overall operating costs. Some of the factors influenced or controlled entirely by lubrication in modern machinery can be listed as follows:

1. Machine down-time and labor for cleaning oil systems.
2. Lubricating oil cleaning (filtering, filter material replacement, centrifuging, etc.).
3. Oil consumption or make-up.
4. Machine parts failure and replacement costs.
5. Power costs.
6. Costs of lubricants and their application.

In presenting these suggestions to the plastics industry no attempt will be made to generalize on recent developments in manufacturing and operating techniques. Actual case histories will be used to illustrate what can and is being done to improve equipment performance. The cooperation of members of the plastics industry with the authors in the actual demonstration of what can be accomplished through better selection and utilization of petroleum will be used throughout. Help in the preparation of this work is also being received from machinery builders. The cooperative spirit evidenced throughout the industry is very gratifying. During the per-

formance of this survey, members of the industry expressed a willingness to make available to other manufacturers the solutions of problems that will contribute markedly to improvements in continuity of equipment operation, to a lessening of repair costs, and a general simplification of certain production procedures affected by petroleum usage.

A subdivision of the machinery will tend to classify the services of petroleum. It will also indicate the sequence of the detailed texts that are planned for subsequent release through the pages of this magazine.

## Hydraulic presses

The hydraulic press is undoubtedly the most widely used machine tool in the plastics industry. Hydraulically operated units cover the entire range of compression and transfer molding through injection and extrusion. In order to insure the continuous trouble-free operation and accuracy of control that is required in precision molding, the fluid medium used must have no adverse effect on packings nor should it deteriorate within the system and so foul pump and control mechanisms. If the motion of the press is not smooth, manual control is difficult. Continuous production presses controlled by electronic-mechanical-hydraulic systems demand that all moving parts function smoothly. Sticking pistons, leaking valves and worn pump parts are the principal problems of such press operation. Here the quality and cleanliness of the hydraulic fluid plays an important part in production schedules.

Pump wear in hydraulic presses, especially in vertical units operating in the plastics industry, is caused principally by a combination of abrasive ferrous oxide formed on the interior of the reservoirs and microscopic particles of plastic dust blown from the mold platens at the end of each operation. These dust particles adhere to the oil wetted plunger surface and are gradually drawn through the packing gland into the oil system. This condition is considerably aggravated when oil deterioration products coat the machine parts with an adhesive deposit.

A further source of contaminants that accelerate pump wear is the metallic soaps formed when the petroleum deteriorates. These metal soaps form sludges that precipitate into the bottom of the reservoir where they are picked up and circulated throughout the entire system. When these sludge formations become aggravated, they deposit on the metal surfaces. At times they varnish hydraulic plungers to a point where the presses not only operate erratically but literally tear the packing gland from its seating.

The problem of pump and plunger wear is further aggravated where water collects in the hydraulic system. Many of the oil decomposition products mentioned are water-soluble organic acids. Metal surfaces in a water-wet hydraulic system are thus exposed to attack from these acids and often become badly etched. In the process of etching these metal surfaces, the acids act with the metals and form soaps which are then free to emulsify and produce harmful sludges. Further, finely divided metal particles are released into the system where they act as a very efficient abrasive, literally grinding away machined surfaces.

In some of the older press installations, water alone is used as the hydraulic fluid. Since water is inexpensive, it would appear to be the most economical fluid to use. If, however, the costs of replacing packing and periodically refinishing control valves and plungers are considered, it can be seen that water alone is not too satisfactory. Where leakage and other considerations prohibit the use of oil as a hydraulic medium, water can be made to serve very successfully by the addition

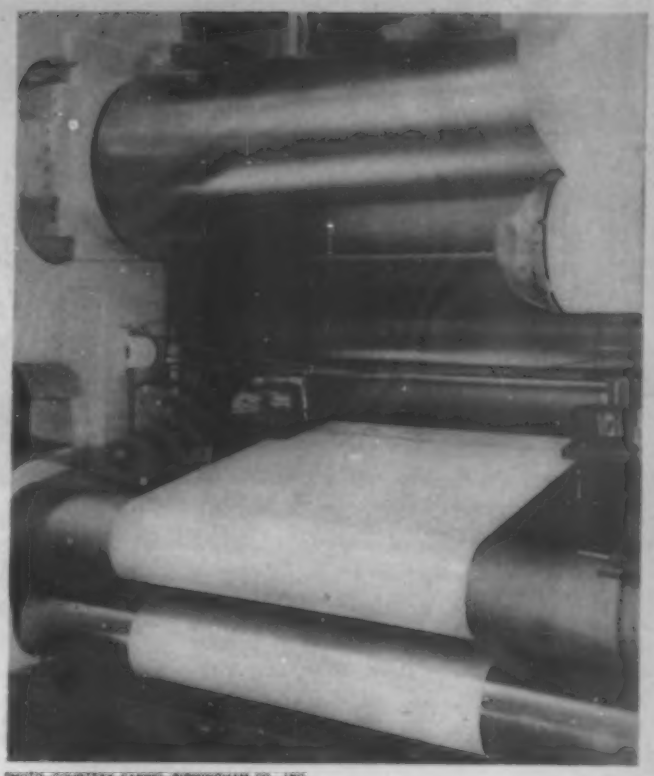


PHOTO COURTESY FARREL-BIRMINGHAM CO., INC.

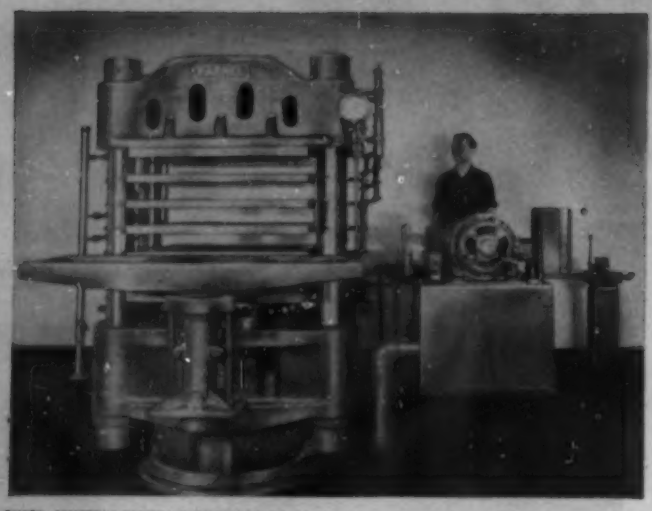
***Temperatures of about 300° F. are usual in the calendering of vinyl resin to a fabric backing. So that these calendering rolls—the entire unit, in fact—will operate at maximum efficiency at this temperature, the lubricant used in their operation must be carefully selected***

of wetting agents and soluble oils. A blend of one part soluble oil to 60 parts water will improve the metal wetting properties of the fluid. This addition of wetting agents and soluble oils to the water also reduces corrosion within the fluid system, thus immediately exerting a protective influence on control mechanisms. Inexpensive mechanical filtering devices should be employed to maintain the fluid stream in a physically clean condition by reducing the concentration of solids to the lowest possible degree.

Modern unit presses are usually equipped with individual reservoirs, pumps and control mechanisms. Presses of these types are best served by oil as the hydraulic fluid. To secure continuous uninterrupted service from this precision-type molding equipment, only oxidation-resistant hydraulic oils containing corrosion preventives should be used. Such oils do not precipitate deterioration products and they greatly lessen oil and machine maintenance.

Corrosion formation on the interior of the oil reservoir is often independent of the oil in that it takes place in the area above the oil level. Corrosion on the underside of the roof or top of the oil reservoir often progresses to a point where rust particles drop into the oil and contaminate the oil stream, thus rapidly promoting wear of pump parts and control valves. The ferrous metal oxides are also active catalysts that accelerate oxidation of the oil. Rust of the interior of oil reservoirs can be entirely eliminated through the use of an oil and water impervious coating. These coatings can be applied at the point of manufacture or after the machine is placed in service.

Accuracy of control, especially in rapidly operated hydraulic presses, is affected by foaming, another function of oil quality and its resistance to deterioration. Small air bubbles en-



PHOTO, COURTESY FARRELL-BIRMINGHAM CO., INC.

***There are a number of ways in which lubricants can effect the operation of plastic processing equipment such as this multi-platen hydraulic press which is used for the production of precision single sheets or laminates. They influence machine down-time and labor for cleaning the oil; oil consumption; machine parts failure; power costs and also the costs of lubricants and their application***

trained in the oil will reduce pump capacity and permit the plunger to retract.

Foaming is common in hydraulic oils that contain even small amounts of acidic and saponifiable material. These oil-decomposition products increase the tendency of the oil to hold moisture and finely divided air in suspension. This is especially true with the incompletely refined oils which allow decomposition to take place much more rapidly than is the case in more thoroughly refined products that are resistant to foaming.

The economy of using oxidation stable hydraulic oils is readily demonstrated by the almost complete elimination of pump control mechanism wear. The removal of all tendencies of the lubricant to deteriorate in service also eliminates the deposition of waxy or varnish-like deposits on press plungers and controls. This, in itself, makes possible the reduction of oil leaks through packing glands and extends the useful life of the packing used. Such preventive maintenance is readily accomplished by periodically filtering the oil in each hydraulic system without removing the press from service or the oil from the reservoir. One filter operator in a plant can contribute more toward press and pump maintenance than ten repair men.

This method of oil and press servicing represents a reduction in the labor and expense involved when compared with efforts made to salvage deteriorated hydraulic oils in an independent recovery system. Maintenance of hydraulic oil by filtration while the press is in operation will, to a very great extent, reduce the need for changing the oil in any given system.

In heating mold platens, extrusion press cylinders and nozzles, plastics dip coating tanks, mill and calender rolls, etc., various methods are employed. Where it is found to be impractical to use direct electrical heating elements, the use of a combination of electric elements and oil is often expedient. Where temperatures are not required much above 350° F. and where structural designs permit the use of high pressures, steam heating appears to be the most practical. Fluid temperatures up to 500° F. can be readily accomplished and maintained through the use of oil under pressure not to exceed 10 lb. gage. Where it is impractical to maintain such pressures, 350° F. appears to be the safe upper limit for oil as a heat transfer fluid. Beyond this temperature, in open systems, rapid oil deterioration takes place. When this happens, frequent cleaning of the apparatus and frequent oil changes are necessary.

## Heat exchange oils

The older conception of petroleum as a heat transfer medium calls for steam-refined cylinder oils having high flash points. Such oils contain unsaturated hydrocarbons which cause them to deteriorate and form tarry, coke-like deposits when subjected to elevated temperatures for any lengthy period in the presence of air. Oils of this type, because they rapidly coat the heating elements and the metal surfaces of the vessels to be heated, soon result in lowered heat transfer rates. It then becomes necessary to increase the temperature of the oil, an action which immediately accelerates the oil deterioration rate. Over the past several years full-scale field investigations have demonstrated that temperature ranges from −20 to +500° F. can be served through the use of relatively light-bodied, highly refined, oxidation-resistant oils.

In open heating system operating at atmospheric pressure, temperatures of 350° F. can be safely maintained, if the area is well ventilated, without undue vaporization or the formation of explosive vapors. Where it is necessary to carry temperatures beyond 350° F., it becomes necessary to raise the boiling point of the oil by maintaining a pressure of not over 10 pounds. Systems using oil as the heat exchange medium have operated in the 500° F. range in excess of four years without any fouling of the heat exchanger surfaces. The oil during this interval has shown no sign of deterioration.

Continuous operating temperatures of 550° F. with intermittent short intervals of 650° F. are being studied to note the behavior of such oils in these ranges. We recognize that as we approach 750° F., regardless of the pressure carried, we reach the zone where oils will actually crack into gasoline and light oils.

Temperatures in excess of 500° F. appear to be those best served by some of the commercial heat exchange fluids. In one resin manufacturing process, Dowtherm is used in the primary heat cycle, heat transfer to the process being controlled by oil in a second cycle. This system has been found to lend itself admirably to process temperature control within narrow limits.

Cleanliness of the interior of heat exchanger systems can be markedly improved with simple inexpensive filtering devices by progressively removing deterioration products from the fluid stream. It is possible to maintain the efficiency of heat exchanger systems at their peak by allowing the clean fluids continually to scrub the surfaces free of all deposits that tend to interfere with the free flow of heat. Instances are on record where simple by-pass filtering devices have completely eliminated the necessity for periodic dismantling of Dowtherm heat exchanger systems for the removal of the black cold cream deposits which are usually precipitated on the relatively low-temperature surfaces of the various process units.

## Plastics mills and roll calenders

Plastics mills and roll calenders of conventional design, having roll temperatures not above 350° F., do not present any unusual roll heating or bearing lubrication problems. Although custom dictates the use of heavy-bodied or viscous

steam-refined cylinder oils for the lubrication of mill and calender rolls, it has been found that lubricants of lower viscosity possessing high oiliness and load-carrying properties provide better protection for such equipment.

Rolls carrying temperatures of 550° F. are contemplated for processing plastics and synthetic rubbers. The heating of such rolls and the lubrication of the roll bearings may necessitate abandoning past practices. It may be necessary to resort to selected hydrocarbon lubricants that become effective in bearing temperature ranges above 500° F.

A further modification of process machine design dictates that rolls in a given calender will be heated while other rolls in the same machine are refrigerated. The two temperature extremes in a single machine will make it necessary to utilize lower viscosity or more fluid lubricants in order to eliminate unnecessary mechanical equipment and to prevent service complications.

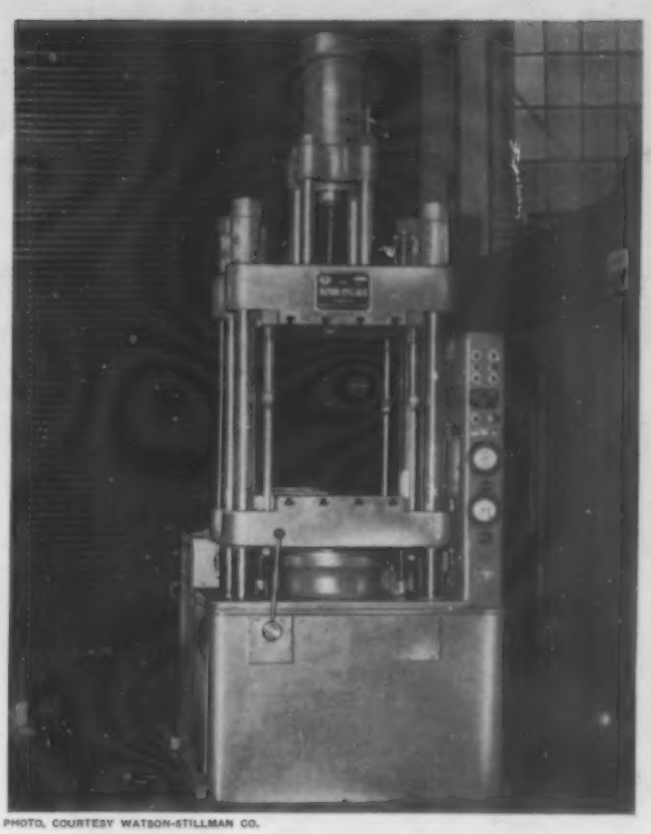
### Lubricating greases

The requirements of lubricating greases in plastics processing machinery are not numerous nor difficult. The principal part of this machinery generally overlooked or lubricated with products falling short of service requirements are the bearing connections in toggle joints and stops on presses. Motion here is very slow and purely oscillating, making it difficult both to apply the lubricant at the point of greatest pressure and to prevent it from being immediately forced from between the surfaces when the press operates. The metal combinations are, because of pressures exerted, steel to steel. Active extreme pressure greases of pressure gun consistency provide the best protection. Such lubricants, compounded so as to provide a strong affinity for metal, resist the shearing and wiping effect of the oscillating motion. Screws, gears and guide rails do not present any unusual conditions of operation that cannot be served by conventional soft lubricating greases.

### Rust preventives in mold platens and machinery

The cost of producing intricate precision items in plastics, especially in injection, compression and transfer moldings, is affected greatly by the services secured from the molds themselves. Because of changes in production it is often necessary to move molds from service and place them in temporary storage. Even slight rusting of the highly finished surfaces destroys the usefulness of the mold though such rust formations can conceivably be removed. Mold rusting can be prevented by washing the mold with a polar type, thin film rust preventive having good solvent properties. Such rust preventives will remove all sweat stains from the surfaces of the molds and displace any water or moisture that may be present.

Where molds are placed in storage for brief periods, no further protection is needed since such corrosion preventives, on drying, leave an almost invisible waxy polar film of protection. If the molds are to remain in storage for an indefinite period, the cleaned mold should be further coated with a petroleum type rust preventive which can be applied either by brush, dip or spray after heating to a satisfactory temperature which usually is about 160° F. Molds and other machinery spares that are washed with fluid rust preventives and coated with soft grease-like protective coatings can remain in storage indefinitely without fear of rusting. When such parts are again placed in service, the corrosion preventives are readily removed from the metal surfaces. This is accomplished by the simple expedient of washing them with regular petroleum solvents.



PHOTO, COURTESY WATSON-STILLMAN CO.

***To insure trouble-free operation and accuracy of control in press equipment, the fluid medium must be of a type which will not deteriorate within the system, 6 fouling the mechanisms or having an adverse effect on packings***

### Air compressor lubrication

Cleaning of mold surfaces in production is usually accomplished by a compressed air lance. Because the mold surfaces must be dust free and perfectly clean at every production cycle, it is necessary that the air stream be physically dry and contain no solid impurities. Much can be accomplished by the effective use of efficient air cleaners on the air compressor intakes coupled with the lowest possible lubricant feed rate that will provide the necessary protection against surface wear in the air cylinders. This reduction of the air cylinder lubricant to a minimum is readily accomplished through the selection of oils possessing the required qualities. Oil feed rates to air cylinders where terminal pressures do not exceed 350 lb. gage should not exceed one quart per 6 million surface feet of piston-swept area.

The air stream from such compressors requires the least amount of filtering to remove water and other contaminants.

This introduction has attempted to present the scope and direction of a survey of the plastics industry being undertaken at present by the writers. Future articles will cover in detail many of the problems that have merely been suggested in the foregoing discussion.

All indications point to an increased demand for plastics materials in the coming years. Industrial and consumer needs will exceed present consumption. Although plastics plant capacities are expanding rapidly, it is questionable whether increased demands can be entirely satisfied. Production equipment now in use and contemplated for the future is engineered for rapid, accurate, continuous production. It is in the interest of uninterrupted equipment life that the more modern petroleum products will best serve.

# Melmac Plastic...

*Receivers and transmitter housings are molded of MELMAC plastic for the Sonotone Corporation by the Northeastern Molding Co., and Lance M fg. Co.*

**COFFEE MAKERS**, tableware and kitchenware molded of MELMAC are durable, light in weight, and easy to handle. MELMAC's hard surface resists abrasion and is not affected by hot water.

# "a Sound" investment

Sonotone checked and double-checked new materials for their ultra-modern hearing aid receiver and transmitter housing—and chose MELMAC* plastic!

Convinced of its quality—but wanting customer opinion on color—they showed samples to nearly a thousand customers. Approval for MELMAC plastic in flesh-tone was enthusiastic. Black was second choice.

There are many reasons why MELMAC was a sound investment for Sonotone:

**1.** MELMAC's hard surface is permanent—won't easily scratch or mar, and is pleasant to the touch.

**2.** Its naturally lustrous, glossy surface saves hours of buffing time in the finishing process.

**3.** MELMAC's wide range of colors permits matching of desired flesh-tone for the housing for their compact 3-tube audio frequency mechanism.

**4.** MELMAC retains its clean, bright luster in spite of perspiration.

Add to this, MELMAC's lightness in weight—chemical inertness—resistance to moisture and heat—and you have the answer to a well-nigh perfect plastic for many uses.

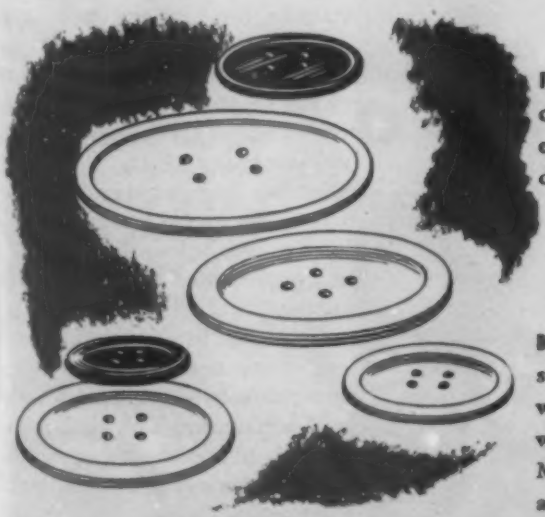
You, too, can establish acceptance for your product by capitalizing on MELMAC's wide range of colors and exceptional physical and electrical properties. We shall be glad to send complete information or to work directly with you.

*Reg. U.S. Pat. Off.*

**AMERICAN CYANAMID COMPANY · PLASTICS DIVISION**
32 ROCKEFELLER PLAZA · NEW YORK 20, N. Y.

## Cyanamid Plastics

*Beetle · Melmac*
*Melurac · Laminac · Urac*

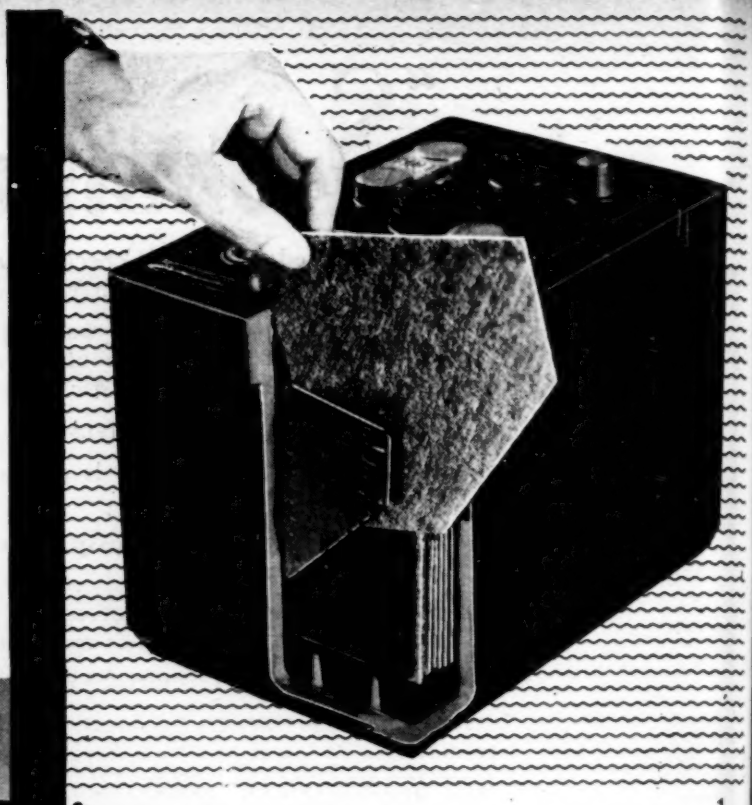


**FOR LIGHTING REFLECTORS,** translucent MELMAC has excellent properties for light transmission and diffusion and heat resistance.

**BUTTONS** are highly resista severe laundering conditio water, and high temper when made of MELMAC plas MELMAC molding material i available in a wide range of colors.

# FROM SAND TO BATTERY SEPARATOR

by T. R. SIMKINS*



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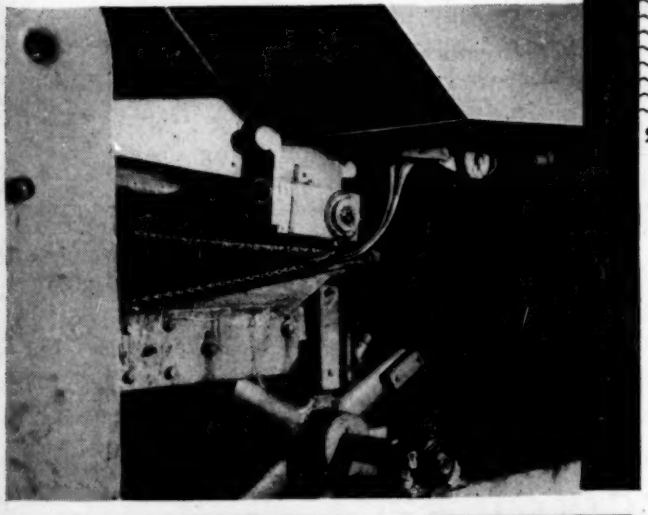
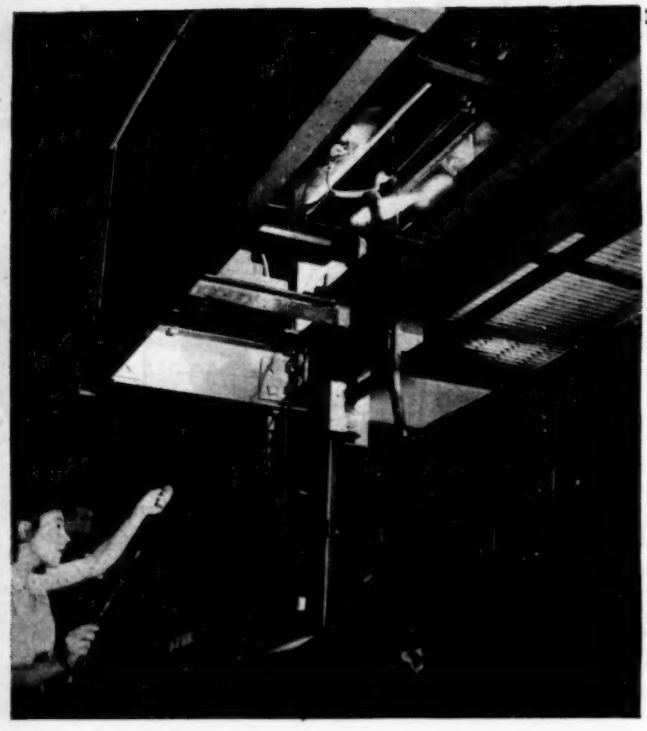




3

***1—This cut-away section of a standard six-volt storage battery shows the location of the glass laminate battery separator. 2—As a column of molten glass is drawn from the furnace, a gear wheel synchronized with a moving conveyor belt presses into the glass and imprints it in such a way that the column is broken up into a continuous chain of nuggets. 3—One filament of molten glass is drawn from each oriface in the overhead reciprocating furnace in which the nuggets are melted***

PHENOLIC resin impregnated fibrous glass mats, which gained a reputation during the war as separators in the storage batteries used in all types of military mobile equipment, may soon be making their appearance as decorative panels, construction materials, electrical insulation boards and air filters. Such mats offer the various characteristics found in glass fibers—dimensional stability, fire, heat and chemical resistance, nonhygroscopic properties and good electrical characteristics. And, through control of the fiber density of the mat during expansion, they can be produced with extremely high strength characteristics. Color is also being added, the fibrous glass mats being dyed in a resinous bath.

While experimental work has been completed on the above-mentioned applications, it is highly probable that batteries will continue to be, as they were even before the war, one of the biggest outlets for resin impregnated glass mats. The difference will probably lie in the fact that whereas recent production was largely for separators, the future demand will be mostly for battery retainers. Some separators may also be produced. However, the process used for manufacturing the separators at the Glasfloss Manufacturing Co., Inc., readily lends itself to conversion. This is an important consideration in view of the sharp demand for batteries equipped with glass

* Technical director, Glasfloss Manufacturing Co., Inc.

fiber retainer mats which is expected to follow upon the recent lifting of gasoline rationing and the swelling production of new cars.

The chief physical difference between these battery elements is the thickness of the mat, the retainer being relatively thin in comparison with the separator—being from 10 to 30 mils in thickness. The real discrepancy lies in the uses to which these two parts are put.

### Distinguishing a retainer mat from a separator

A retainer mat, used in the majority of automobile batteries, is a thin fibrous glass mat placed next to the positive plates to hold the active materials in place, prevent shedding which shortens the life of a battery, and provide a reservoir for the electrolyte. They are always used in conjunction with either wood or rubber separators, and just about 50 percent of the replacement storage batteries now being manufactured have these mats.

A separator, on the other hand, can be either a porous strip of wood, rubber or glass fiber from 0.030 to 0.100 in. thick. Placed between the plates of a battery, it acts to separate, as the name implies—to prevent metallic conduction, or treeing, between the plates while permitting free and unrestricted circulation of the electrolyte. In fact, one of the chief problems that arose during the development of the Glasfloss separator centered in the achieving of a proper balance between metallic and electrolytic conduction. This was finally accomplished through the use of a continuous filament textile type glass fiber that was formed into a mat having a fixed fiber density.

Perhaps the importance of the development of this plastic and glass fiber separator can best be explained on the basis of the difference between a wet storage battery and a dry charged storage battery. As the name implies, in a dry charged battery positive and negative plates are charged in the regular manner. These are then dried and preserved by a special process. They are then assembled in an absolutely dry rubber case whose vents are sealed. In this dry state the fully charged battery can be shipped long distances or stored for long periods without danger of deterioration. When, finally, it is to be put to use, it remains only to open the vents and add the electrolyte or acid. At the very least the battery will have 75 percent of its rated capacity.

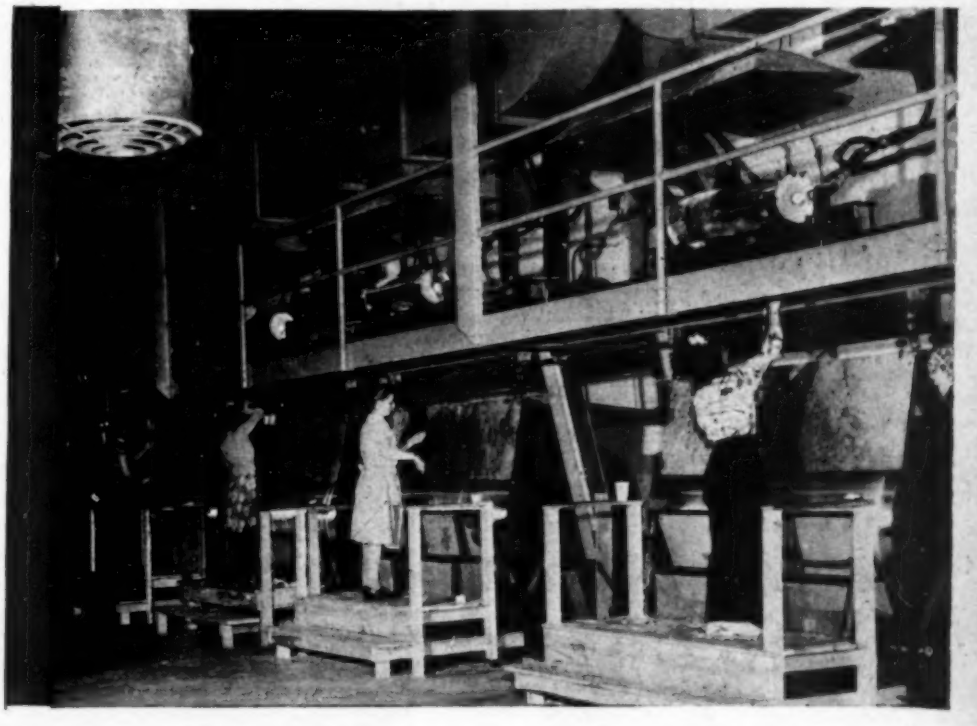
In contrast, a wet storage battery, which is filled with the electrolyte throughout the storage and shipping periods, will become self-discharged and require recharging before it is ready for use. Further, the acid in this type battery is often lost during handling and shipping, rendering the battery useless and causing damage to other materials.

In view of this discrepancy in conditions for use, it is small wonder that dry charged batteries became a must for mobile military equipment. G. I. trucks, jeeps, tanks and like equipment were needed in operation as soon as they were unloaded—not after a period of layup for battery recharging. For the same reason, many manufacturers who built dry batteries with glass floss separators during the war are considering continuing on the same production—supplying these units for civilian trucks and cars.

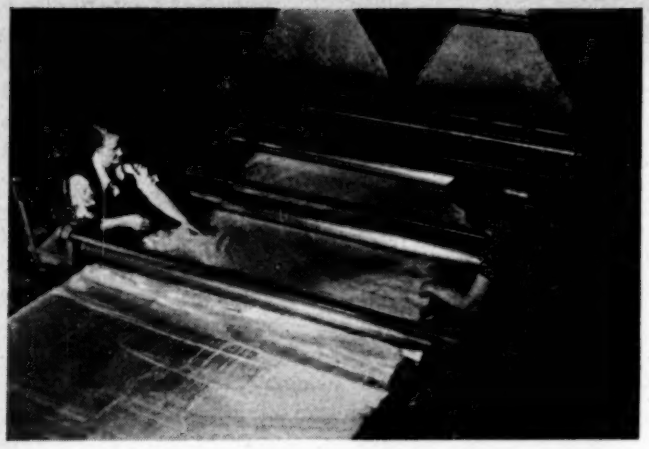
But whatever the application, the composition of the phenolic resin-impregnated glass floss mat is basically the same, and a description of the processing of Glasfloss separators applies in almost all particulars to the production of other forms of this material.

### Making the mats

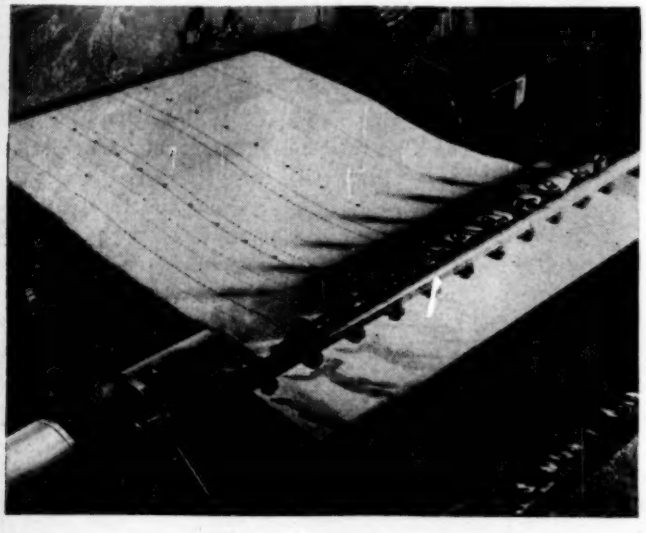
The manufacture of the mats starts with sand and other raw materials being turned into a glass of special composition in a glass batch plant. So that the small glass spinning furnaces can be fed automatically and uniformly, the glass is then formed into small nuggets. This is accomplished by drawing the molten glass from a large continuous glass furnace through two feeders. Both these units feed a conveyor with a hot viscous glass column. A gear wheel, which is synchronized with the moving belt, presses into this molten glass, imprinting it in such a way that the column is broken up into a continuous chain of nuggets that are held together by attenuated strands of glass. Intermittent currents of air play over this moving mass of glass, blown from a slotted air conduit placed over the conveyor. In this way the glass columns are cooled, and the hardened nuggets tend to separate as they fall into a hopper. (*Please turn to next page*)



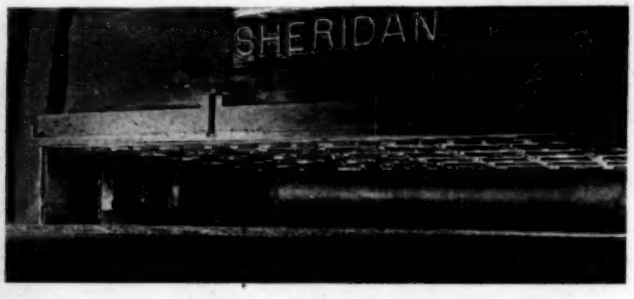
*4—When an operator has succeeded in drawing a filament from each oriface in the reciprocating furnace, she transfers all the strands to a spinning drum. This operation is always necessary at the very beginning of a run*



*5—After the glass mats have been built up to the proper thickness on the revolving drums, they are removed and placed in position on this section of a continuous treating machine for the purpose of expanding the pattern of the fibers. The difference in the speed of the rollers controls the pattern that the fibers take in the mat*



*6—After expanding, the material is carried through a resin impregnating bath. The resin content of the mat is then accurately metered by means of a suction system which removes excess resin from the body of the glass mat. Black lines indicating the direction in which the battery separators must be inserted in the batteries are marked on the mat by a series of dye applicators*




*7—After the glass mat has passed through the long curing oven, an automatic toggle press, which is equipped with a steel rule die, accurately cuts the mat into separators*

After inspection the nuggets go to the processing plant for remelting and conversion into fibrous glass mats. For this work the highest quality glass is essential. The spinning units consist of specially designed furnaces with capacities of 240 cu. in. which are mounted on a platform above a wide spinning drum. Weighed quantities of nuggets are intermittently added to each furnace automatically, maintaining the charge of glass at a fixed level and at optimum operating temperature.

As the spinning of the glass fibers starts, the operator in charge of the drums on which the glass mats are formed, pulls filaments of molten glass through openings in a specially designed plate on the underside of the furnace. The point of a tapered rod is used to contact the glass at each of the holes and to pull down thinning columns of the molten material. When the glass filaments reach the level of the spinning drums, the operator grasps them in his hand and pulls them until they begin to come through the openings in the furnace clear and of the specified diameter. The oversize glass columns are then broken off and discarded, and the clear fibers placed on the spinning drum which further attenuates the continuous glass filaments as it starts to rotate. As the drum turns round and round, the glass furnace shuttles back and forth above it. Thus a mat is built up in which the glass fibers overlay each other in a fixed, criss-cross pattern.

In the formation of these fibrous glass mats from fiber of a definite and predetermined size, it is essential that the refractory material in the furnace be such that it does not crumble or dust off at the maximum heat and that the following four factors in the production remain constant:

1. The composition of the glass nuggets.
2. The temperature of the molten glass.
3. The temperature of the furnace plate.
4. The level of the molten glass in the furnace.

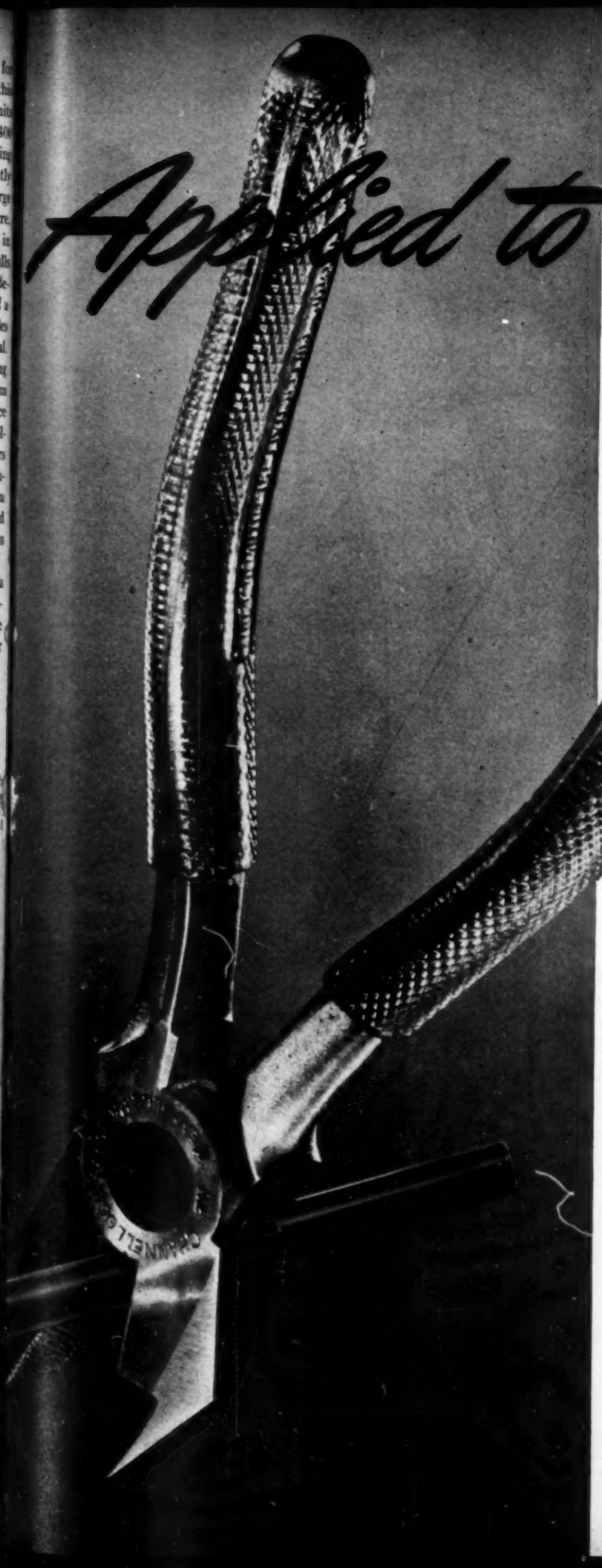
When the desired amount of glass fiber is spun, the overlay of fibers on the drum forms a complete continuous filament mat conforming to the circumference of the drum. This mat is then cut across the surface at two places to form two sections which are identical in length, width and weight. Each half-mat is taken from the drum, placed on a portable platform and removed to a dry storage place that is free from air currents until it is ready for expanding and bonding.

## Expanding and bonding

Both Catalin and Durez water soluble phenolic resins are used as bonding agents. When ready for use, the solution is pumped from a resin room, which is maintained at a constant temperature, to the mat expanding line.

At the same time, the half-mats are placed on an expander conveyor which is equipped with a series of expanding or drafting rolls designed to rearrange and expand the continuous fibers into a mat having a fixed fiber arrangement which will give the storage battery separators the proper porosity. In the process of expansion the fiber pattern of the mat is extended so that it gives an appearance similar to the warp and woof of a woven textile. The speed of these rolls is controlled individually so that a wide arrangement of fibers may be obtained should mats of a different consistency be needed for other applications. Thus mats varying in thickness from 0.0050 to 0.250 in. can be produced.

Further variation in the final mats can be achieved by varying the type of impregnating resin. An important point is that the resins can be applied by this method to chemically clean glass fiber. The expanded mat is conveyed from the last expanding section to a dip tank where resin sprays across the width of the mat. The impreg- (*Please turn to page 218*)



*Tenite plier handles molded by Franklin Plastics Division for R. J. Miller Equipment Company*

# Applied to Pliers

• Tubular sleeves of red Tenite are forced cold onto the handles of ordinary pliers. Extra tough and resilient, the plastic sleeve conforms tightly to the shape of the plier handle without cracking or splitting.

Tenite has high dielectric strength, affords ample insulation for work on electric lines. The sleeves are molded with diamond-knurling, making a grip ideal for handling with slippery leather gloves or with bare hands in cold weather. The red plastic makes pliers easier to see in grass, dirt, or snow.

Tenite plier handles are injection-molded four at a time at the rate of better than ten thousand daily. From raw molding material to finished article ready for sale is a matter of only a few minutes. Tenite is available in a number of formulas suited to many different uses. For information about Tenite and its adaptability to your product, write TENNESSEE EASTMAN CORPORATION (Subsidiary of Eastman Kodak Company), KINGSPORT, TENNESSEE.

**TENITE**

*An Eastman Plastic*

# MACERATED FABRIC

By the addition of fillers, thermosetting plastics become tougher and stronger are less inclined to shrinkage – are more favorable in cost! When end-use requirements demand higher impact, greater tensile and compressive resistance, you'll do well to check the muscle-building qualities of Claremont fillers.

Comprising flock, fabric, thread and cord, these textile by-products are clean, graded and uniform. For example: Claremont Macerated Fabric, when used to fill, raises impact values to 12 times that of woodflour.

Each of Claremont's fillers helps to obtain improved results– each holds an important place in plastics formulations. Samples of all four types are available. Claremont invites the opportunity to fill-in whenever your plastic material problems call for a strong lift.

**CLAREMONT**

**WASTE MANUFACTURING CO.**

**CLAREMONT, NEW HAMPSHIRE**

THE COUNTRY'S LARGEST MANUFACTURERS OF FLOCK

# Plastics in Germany, 1939-1945*

by G. M. KLINE†

***Developments in the German plastics industry during the war have been thoroughly investigated by teams composed of technical representatives of the Ordinance Department, Quartermaster Corps, Chemical Warfare Service, Technical Intelligence Industrial Committee and other groups. The Department of Commerce is merely distributing this technical information which has come into its hands from captured German territory. This information should be made available to all United States citizens interested in it, but use of it by anyone must be and is at one's own risk insofar as the United States or foreign patent violations are concerned.***

THIS survey of developments in the German plastics industry during the war period 1939–1945 is based on data obtained in a three months' investigation of the important plants in Germany made under the auspices of the Office of the Chief of Ordnance, War Department.

The conversion of nature's raw materials by synthesis into a myriad of useful products has always been a special forte of scientists in Germany, the birthplace of organic chemistry. Their efforts toward attaining self-sufficiency in domestic supplies of fuels, oils, rubbers, textiles and fats are well known to the world. Similarly, in the synthetic resin field their scientists have developed many of the compounds which are used for the production of molded plastics, films and foils, improved leather-type goods, and protective coatings. It was to be expected, therefore, that just as our War Production Board made provisions for the expansion of our plastics industry to take care of expanding military needs for these materials, the Reichsstelle Chemie in Berlin had drawn up Deutscher Kunststoffplan and Lackstoffplan to meet their estimated requirements for the various synthetic resins.

The molding of plastics in Germany is largely in the hands of small independent operators. Compression presses are generally of the conventional type. The larger sizes, up to 5000 tons capacity, are designed to provide 8-point support for the moving platen which may be either the lower or upper member. Principal manufacturers of compression presses in Germany are Becker and van Hullen, Joh. Kleinewefers Sohne, and G. Siempelkamp and Co., all in Krefeld, Hahn und Kolb, Stuttgart and Franz Braun A.-G., Zerbst.

Injection molding is done on a much smaller scale in Germany than in the United States; most of the injection presses are of 2- to 4-oz. capacity. The principal manufacturer of this type of press is Eckert und Ziegler, formerly of Koln and evacuated to Bamberg (Bavaria) in 1944.

In general the German manufacturing processes and fabricating techniques, other than molding, are well advanced. The outstanding features of processes and techniques as well as the principal purposes for which plastic were used in Germany will be summarized in this survey.

## Polyvinyl chloride

In the I. G. organization the monomer vinyl chloride is made chiefly at Schkopau with a small amount at Rheinfelden; total production was approximately 3500 tons per month. Acetylene and hydrogen chloride are combined in the presence of a mercuric chloride catalyst. The monomer is stored or shipped in steel tanks under nitrogen at 10 to 12 atmospheres pressure.

The main production of polymer is at Bitterfeld with a little at Schkopau and Ludwigshafen; total production was approximately 2700 tons per month. The standard process is emulsion polymerization in a mixture of 100 parts vinyl chloride, 100 parts water (purified by double ion exchange with phenolic and aniline resins), 4 parts Mersolate (sodium salt of $C_{12}$-$C_{18}$ Fischer-Tropsch hydrocarbons with chlorine and sulfur dioxide), and 0.4 part of 40 percent hydrogen peroxide. A 90 percent yield of polyvinyl chloride is obtained.

A wide variety of mixed polymers is made by I. G. Farbenindustrie A.-G. The compositions, tonnage (short tons) produced in 1942, cost per kilogram, and selling price per kilogram of the products made with vinyl chloride are:

| *Igelit type* | *Composition* | | *1942 production* | *Cost* | *Selling price* |
|---|---|---|---|---|---|
| | | | *tons* | *mk./kg.* | *mk./kg.* |
| .... | Vinyl chloride (VC) | | 2216 | 0.44 | .. |
| PCU | Polyvinyl chloride (PVC) | | 970 | 1.08 | 1.90 |
| PC | Chlorinated PVC | | 907 | 3.50 | .. |
| MP-A | VC | 80 | 621 | 1.55 | .. |
| | Dimethyl maleate | 10 | | | |
| | Diethyl maleate | 10 | | | |
| MP-K | VC | 84 | 882 | 1.21 | 1.90 |
| | Methyl acrylate (MA) | 16 | | | |
| MP-AK | VC | 80 | 307 | 1.31 | .. |
| | MA | 13.5 | | | |
| | Diisobutyl maleate | 6.5 | | | |
| MP-400 | VC | 73 | 116 | 1.51 | .. |
| | Vinyl isobutyl ether | 27 | | | |
| MP-S | VC | 55 | 6 | 1.45 | .. |
| | Vinyl acetate | 45 | | | |
| MP-D | VC | 80 | 1.4 | 1.41 | .. |
| | MA | 20 | | | |
| MP-VB | VC | 85 | 1.6 | 1.60 | .. |
| | Butyl acrylate | 15 | | | |

Dr. Alexander Wacker G. m. b. H., Burghausen, produces about 200 tons per month of monomer and 260 tons per month of polymer comprising 3 grades of polyvinyl chloride:

| | |
|---|---|
| Vinnol HH | $K$ = 70–80 |
| Vinnol H | $K$ = 65–70 |
| Vinnol K | $K$ = 60 |

The most commonly used measure of the molecular weights of vinyl chloride polymers in Germany is the Fikentscher $K$ value. This is an empirical value determined by measuring the viscosity of a 1 percent solution of the polymer in cyclohexanone. Fikentscher's viscosity coefficient, $K$, is calculated as follows:

$$\frac{\log \eta_{rel}}{c} = \frac{75K^2}{1 + 1.5Kc} + K$$

(*Please turn to next page*)

* The opinions contained herein are those of the author and are not to be construed as reflecting the views of the War Department.

† Chief, plastics Section, National Bureau of Standards.

*1—Lt. Col. J. W. C. Crawford, Col. G. M. Kline (author), Col. J. H. Rooney, and Major Thomas Love, Frankfurt bound*

where $c$ is the concentration in g./cm.$^3$ of solution and $\eta_{rel}$ is the ratio of the viscosity of the solution to that of the pure solvent.

## Applications of polyvinyl chloride

Vinnol is said to have better electrical properties than Igelit because the finished washed product contains only about 0.1 percent emulsifier, polyvinyl alcohol. The water absorption of Igelit is said to be 8 percent after 25 days, whereas that of Vinnol is only 0.3 percent. Vinnol was supplied to Neumeyer in Nurmberg and to Siemens in Berlin for use as cable covering. The plasticized compound is passed through an extrusion machine and thence to a pair of extruders which applied it to the wire.

Igelit PCU is used unplasticized for the production of approximately 2000 tons per year of Vinidur sheets, rods, tubes and moldings. It is heated on rolls at 160° C. and then extruded as rods by flash heating to 190° C. Apparatus for the continuous production of press-polished sheets was developed experimentally at Bitterfeld and Troisdorf, but has not been operated successfully. No satisfactory stabilizer for polyvinyl chloride has been found and the Vinidur products are always discolored brown. Sodium carbonate or phenyl indole stabilizer neutralizes the liberated hydrochloric acid. The Vinidur products are very resistant to chemicals, both acid and alkaline, below the softening point, 60 to 70° C. They can be welded or may be cemented with a solution of Igelit PC. Vinidur pipes and containers are used very extensively in the German chemical industry.

Unplasticized polyvinyl chloride is also used to produce film of 1.0 to 1.4 mil. thickness. The process employed in making this film, called "Luvitherm," is to hot-roll the polyvinyl chloride at 165° C. for 5 to 10 min., transfer to a calender for filming on rolls at 165 to 170° C., heat for a few seconds on a roll at 260° C., and stretch on a roll heated to 120° C. The film coming off the calender is 50 cm. wide and 50 microns thick; this is reduced in stretching to 32 cm. width and 30 ± 5 microns thickness. The maximum stretch is about 270 percent. The plant at Ludwigshafen, now transferred to Gendorf, is designed to make 8 to 10 tons of Luvitherm film per month. A larger plant had been designed to make 16 to 20 tons per month, using calender rolls 110 cm. wide to produce a film 75 cm. wide, reduced on stretching to 60 cm.

Luvitherm is the first dry-processed unplasticized polyvinyl chloride film made in Germany. It is of immediate interest as a packaging material for protection against tropical conditions. Heat sealing is difficult because the tack point is high, but the film can be cemented by the use of cyclohexanone or tetrahydrofurane and pressure. The tensile strength of the stretched film is 17,000 p.s.i. lengthwise and 5700 p.s.i. crosswise; elongation is 15–30 and 5, respectively, in the two directions. It will withstand approximately 10,000 folds lengthwise and 1000 crosswise in the Schopper flexing test. The heat resistance of the film is comparatively low, 80 to 84° C. in the Martens test. It is not suitable for high voltage electrical work.

An interesting application of this Luvitherm film is the Magnetophone recording and transcribing device developed by I. G. Farbenindustrie A.-G. and Allgemeine Elektrizitats-Ges., Berlin. It is composed of a Luvitherm film 0.035 mm. thick on which is cast by means of a doctor blade a coating 0.008 to 0.010 mm. thick from a mixture consisting of equal parts of Igelit MP-400 and magnetic iron oxide in tetrahydrofurane and vinyl isobutyl ether, the solution having a viscosity of about 50 poises. The iron oxide is produced by reacting ferrous sulfate, ammonia, and ammonium nitrate in aqueous medium to crystallize out black magnetic iron oxide. This is then oxidized at 230° C. for 6 hr. in an agitated drier with air blowing through to give 1-m$\mu$ crystals of ferric oxide possessing magnetic properties.

The plasticizers used in compounding polyvinyl chloride are tricresyl phosphate, triethyleneglycol caproate, triethyleneglycol dihexoate, trihexyl phosphate and dibutyl phthalate. New plasticizers, called Elaols, were made by esterifying glycols with the lower members of the fatty acid series ($C_5$-$C_9$) produced by the oxidation of Fischer-Tropsch paraffins, which consist mostly of straight chain hydrocarbons. Elaol I is the triester of hexanetriol with the fore-run fatty acids in the range $C_5$-$C_7$; similarly Elaol II is made with fatty acids in the range $C_7$-$C_9$. About 40 percent of Elaol with a little tricresyl phosphate or dibutyl phthalate gives a Mipolam with good cold and water resistance, satisfactory for cables and soft rubbery products. In general, phenoxyacetic esters made with glycols were observed to be best for high-temperature resistance; aliphatic esters are best for low-temperature resistance.

Approximately 4000 tons per year of Mipolam were used in Germany during the war for wire insulation, fabric coating, raincoats, shower curtains, rollers for textile machinery and the like. High molecular weight polyvinyl chloride was used for making bicycle tires and shoe soles. The bicycle tires were extruded at 160 to 180° C. using a composition of 100 parts polyvinyl chloride and 80 parts of plasticizer consisting of a 50:50 mixture of trihexyl phosphate and triethyleneglycol dihexoate. These tires have been used since 1939 because of the non-availability of rubber.

The material for shoe soles contained about 50 parts PVC, 35 parts plasticizer and 15 parts fillers, such as carbon black, woodflour and kieselguhr. These soles have been used in Germany under the name P Sohle since 1937. Strength and abrasion resistance decreases as the amount of filler is increased. Cold flow improves up to 40 parts filler (carbon) and then decreases. An investigation of slip resistance of P Sohle showed that a pattern containing 25 squares to the square inch had the best resistance. For attaching the soles to shoes a solution of polyvinyl chloride acetate (60 percent choride and 40 percent acetate) in acetone was used.

Polyvinyl chloride pastes are used for sheet goods, coated packing bags, dipped goods and special molding. During 1942 approximately 600 tons of Igelit PCU paste P were

produced at Bitterfeld; this paste has the following composition:

| | |
|---|---|
| Igelit PCU | 50 |
| Tricresyl phosphate | 50 |
| Filler | 10 |

It cost 1.03 mk./kg. to produce and was sold for 1.60 mk./kg. The paste is gelatinized by heating to 160 to 200° C. and forms soft shapes with tensile strengths as high as 1400 p.s.i. Heavy sections up to 1 in. in thickness have been produced.

Another plasticizer used in making these pastes is Mesamoll, which is less flammable and more volatile than tricresyl phosphate, but is better in cold flexing. Fischer-Tropsch hydrocarbons in the range $C_{12}$-$C_{18}$ are chlorosulfonated by treatment with chlorine and sulfur dioxide using ultraviolet light catalyst, and then the sulfone chloride is reacted with sodium phenolate to put a phenoxy group on the molecule, $RSO_2O$-$C_6H_5$. It is a cheaper plasticizer than tricresyl phosphate; 200 to 300 tons per month were produced.

The chlorinated polyvinyl chloride is made by treating a 10 percent solution of PVC in tetrachloroethane at 90° C. with chlorine for 24 hours. It is used for PC fibers and bristles, chemical-resistant coatings, and Vinifol films for packaging and electrical insulation.

Igelit MP-A, stabilized with sodium carbonate, is used without plasticizer for the production of rigid, press-polished transparent sheets, marketed under the trade name Astralon. The applications of this non-flammable transparent plastic include dials, signs, windows, drawing instruments, playing cards and slide rules. Igelit MP-K is used largely for extrusion over cables, being more flexible than A. Igelit MP-D is the same as MP-K except that the emulsifier has been washed out; it is used for dentures. Igelit MP-AK is employed for transfer molding of storage battery cases. Igelit MP-400 is useful in adhesives and lacquers because it dissolves easily in ordinary solvents and has excellent adhesion and resistance to water, acids and alkalies. The vinyl ethers are cheaper than the acrylic esters; hence, these copolymers are thought to have a good future.

## Polyvinylidene chloride

Experimental work has been under way at Ludwigshafen and Wolfen on production and use of this polymer for bristles but only mediocre results have been obtained. This may be attributed to the lack of the special nickel alloys required for the machinery used in its fabrication. A 50-ton per month monomer plant has been built at Schkopau. Various copolymers have been produced at Ludwigshafen, including 90:10, 85:15 and 80:20 proportions of vinylidene chloride:vinyl chloride. Known as Dichlorid or Diorid, 18 tons of a compound containing 84 vinylidene chloride, 15 vinyl chloride and 1 acrylonitrile were made in 1942 at a cost of 3.53 mk./kg. Polyvinylidene chloride:vinyl chloride copolymer is known as Igelit PC 120 at Wolfen. It is expected to replace Igelit PC as a more economical product.

## Polyethylene

Investigation of the polymerization of ethylene was started at Ludwigshafen in 1938. Two types of polymers were produced: Lupolene N, a low molecular weight product, and Lupolene H, a high molecular weight product.

Lupolene N is a waxy polymer, melting point 105 to 108° C., 2000 to 3000 molecular weight, $K = 20$. It is made by polymerizing in methanol at 200 atmosphere pressure, using benzoyl peroxide catalyst. After the preliminary work at Ludwigshafen in a pilot plant of 500-kg. per month capacity, production was transferred to Zweckel/Essen, where a plant was constructed in 1942 to make 10 to 20 tons per month. The Zweckel product is known as I. G. Wachs A.

Lupolene N is used primarily for addition to Oppanol B 150 and B 200 (polyisobutylene of molecular weights 150,000 and 200,000), with which it is compatible in all proportions, to make rolling and calendering easier. Ten percent of the wax reduces cold flow and improves the tensile strength of the Oppanol film. Lupolene N also finds application as a constituent of shoe, floor and furniture polishes. The wax is mixed with paraffin of 50 to 52° C. melting point as an extender and is dissolved in Fischer-Tropsch naphtha.

Lupolene H is a high molecular weight (15,000–20,000) polyethylene, $K = 65$ (in 0.2 percent solution in decalin), melting point 115 to 116° C. It is made by polymerization of ethylene without solvent at 2000 atmosphere pressure with a controlled amount of oxygen as catalyst. The pilot plant at Ludwigshafen was destroyed by a butadiene explosion in September 1944 and production was transferred to the Gendorf plant to escape the Allied air raids. A plant to produce 5 tons per month was under construction at Gendorf in May 1945 and was expected to be ready for operation in July. Lupolene S is off-grade polymer produced during the manufacture of Lupolene H.

Lupolene H is thought to be somewhat crosslinked as compared to the British Polythene, which is a straight chain polymer and has better solubility in benzene. The power factor is 0.0005, which had led to its use in high-frequency insulation, radar equipment and submarine cable. Films for condenser dielectrics have been made experimentally on hot rolls to 0.1 mm. thickness and by melt extrusion to 0.05 mm. thickness. Gelatin emulsions will not adhere to the polyethylene film. Experimental work has also been conducted on spray-coating the powdered material and on its use in film form as a heat-sealing wrapping material. Lupolene H has been incorporated with polyisobutylene to the extent of 10 to 20 percent to improve the tensile strength of

*2—A bomb alley in the I. G. works at Ludwigshafen. The Rhine river can be barely glimpsed in the far background*

the latter material. It has also been formed into various articles by compression and injection molding.

## Polystyrene

The monomer styrene is made at Ludwigshafen and Schkopau. The plant capacities were about 1000 tons per month at Ludwigshafen and 1700 tons per month at Schkopau. The styrene is produced by catalytic cracking of ethylbenzene formed by direct alkylation of benzene. Continuous production processes are used both for ethylbenzene and styrene.

An important feature of the styrene production is the catalyst developed for the dehydrogenation of the ethylbenzene. The composition of the catalyst, known as Lu 144G, is as follows:

| | *Percent* |
|---|---|
| Zinc oxide | 82 |
| Aluminum oxide | 8 |
| Calcium oxide | 5 |
| Magnesium oxide | 5 |
| | 100 |
| Potassium chromate | 3 |
| Potassium sulfate | 3 |

The zinc oxide is prepared from zinc sulfate by precipitation with ammonia. The aluminum oxide is prepared from aluminum sulfate. The other chemicals were obtained in pure form from chemical manufacturers. The oxides are mixed with a little water to form a paste which is extruded as a rod of about 5 to 6 mm. (1/4 in.) diameter and broken up into pellets of 8 to 16 mm. (3/8 to 5/8 in.) length. The potassium chromate and potassium sulfate can be mixed with the oxides in the paste stage or can be sprayed in aqueous solution on to the pellets. The Lu 144G pellets do not tend to disintegrate on handling and in use as did the previously employed catalysts. This catalyst operates when fresh at 560 to 570° C. to give a 93 percent yield; after 1 1/2 yr. at 600 to 610° C. to give an 88 percent yield. The useful life of the catalyst is 2 years.

Polymerization of the styrene is accomplished by three different methods: block, emulsion and solution. Block polymerization is carried out without catalyst in a tower consisting of six sections independently heated. The styrene is passed through the 60-cm. diameter tower at the rate of 40 kg./hr. at various temperature levels up to 180° C. It emerges from the bottom of the tower onto a continuous metal band on which it is formed into a ribbon 30 to 40 mm. wide and 4 mm. thick. The cooled product is fed into a grinder which converts the polystyrene into granules of 2 to 3 mm. particle size.

*3—Here is the Rohm & Haas factory at Darmstadt. This could be a picture of almost any part of the city today*

The *K* value of this product is 58 to 60 (m. w. 50,000 to 60,000) if styrene is fed directly into the tower and 70 to 72 (m. w. 120,000) if prepolymerized styrene is introduced into the tower. The product is designated as Polystyrol L in the former case and III in the latter. Polystyrol IV is a polymer prepared by stopping the reaction at the prepolymerization stage and recovering the polymer from its 35 percent solution in the monomer by drying. It has a molecular weight of about 450,000. At peak production in Ludwigshafen 400 tons per month of block polymer were made. Capacity is now only about 120 tons per month due to bomb damage.

Emulsion polymers of styrene are made in water using potassium persulfate as a catalyst. For special electrical purposes the polymer is prepared with hydrogen peroxide which does not remain in the final product. Amphoseife 18, which is the sodium salt of oxyoctadecane sulfonic acid, is used as the emulsifying agent. Emulsion polymerized Polystyrol EF has a *K* value of 125 to 130, which is said to correspond to a molecular weight of approximately 1 million.

Still higher molecular weight products (*K* = 145) can be made by adding 0.1 percent divinylbenzene to the styrene during polymerization. Styrene copolymerized with acrylonitrile by the emulsion process is known as Polystyrol EN and has a *K* value of 105 to 110, corresponding to a molecular weight of 600,000. Polystyrol EH, a copolymer with vinyl carbazole and acrylonitrile, has a *K* value of 100 to 105 (m. w. = 500,000). Approximately 70 tons per month of emulsion polymers can be produced, based on solids content.

Solution polymers of styrene are made in organic solvents and are of lower molecular weight than block or emulsion polymers. Polystyrol B is a copolymer of styrene and isobutyl acrylate prepared in ethylbenzene. It has a *K* value of 40 to 45. Production of the solution polymers is only a few tons per month.

The compositions, 1942 tonnage and cost and selling prices per kilogram of the various polymers made with styrene in Ludwigshafen are as follows:

| *Type* | *Composition* | | *1942 production* | *Cost* | *Selling price* |
|---|---|---|---|---|---|
| | | | *tons* | *mk./kg.* | *mk./kg.* |
| .... | Styrene | | 4671 | 0.85 | 3.40 |
| III | Polystyrene | | 4363 | 1.05 | 2.50 |
| IV | Polystyrene | | 74 | 1.21 | 4.20 |
| EF | Polystyrene | | 276 | 1.82 | .. |
| EN | Styrene | 70 | 2 | 1.88 | .. |
| | Acrylonitrile | 30 | | | |
| EH | Styrene | 50 | .. | .. | .. |
| | Acrylonitrile | 25 | | | |
| | Vinyl carbazole | 25 | | | |
| B | Styrene | 70 | 9 | 1.42 | 4.40 |
| | Isobutyl acrylate | 30 | | | |
| L | Styrene | 95 | 158 | 1.00 | 3.00 |
| | Toluene | 5 | | | |

Polystyrol III (m.p. 65 to 70° C.) is the principal grade used for injection molding of electrical insulating parts, containers, combs and the like. Polystyrol IV (m.p. 70 to 75° C.) is slightly more heat and shock resistant than III.

Polystyrol EF (m.p. 70° C.) is also used for injection molding, particularly for fuse parts during the war, and has some application as an emulsion for sizing paper.

Approximately 4500 tons of Trolitul molding powder were made in 1944. Polystyrols EN (m.p. 80 to 85° C.) and EH (m.p. 90 to 95° C.) are used for making printing type because of low shrinkage, abrasion resistance and solvent resistance. The EH copolymer is also used for laboratory apparatus because of its resistance to boiling water. Polystyrols B and L are used in lacquers. The B is more flexible and soluble in common lacquer solvents. Its low viscosity also makes it easier to apply as a coating and to produce a smooth film.

Another application of polystyrene in Germany is its use for the manufacture of foil for electrical insulation. This is made by the Norddeutsche Seekabelwerke A.-G., Nordenham/Bremen, on a specially developed machine. The polystyrene is extruded as a tube of 1 to 2-mm. wall thickness and drawn over roller bearings on a conical form to stretch and orient the film in two directions. The thickness is reduced to 0.01 to 0.02 millimeter. The foil is called Styroflex.

## Polyamides

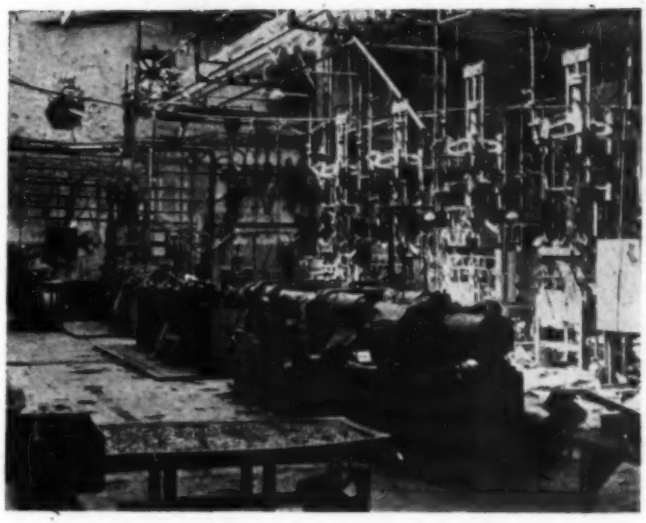
The compositions of the various types of Igamides and the 1942 production figures and costs are as follows:

| *Type* | *Composition* | | *1942 production* | *Cost* |
|---|---|---|---|---|
| | | | *tons* | *mk./kg.* |
| A | Adipic acid | | 765 | 3.60 |
| | Hexamethylenediamine | | | |
| | E-Aminocaprolactam | | 914 | 3.60 |
| B | Polycaprolactam | | 915 | 4.45 |
| 6A | Igamide A | 60 | 912 | 4.73 |
| | Igamide B | 40 | | |
| 5A | Igamide A | 50 | 38 | 4.85 |
| | Igamide B | 50 | | |

Adipic acid is made at Leuna by hydrogenation of phenol to cyclohexanol which is oxidized to the dibasic acid with nitric acid at 90° C. With phenol at about 0.75 mk./kg., it costs 1.20 mk./kg. The hexamethylenediamine is made at Ludwigshafen from adipic acid. The caprolactam is made at Leuna by dehydrogenation of cyclohexanol to cyclohexanone, which is converted to the oxime with hydroxylamine. This is rearranged by 25 percent oleum to a seven-membered ring compound, caprolactamhydrosulfite, which is neutralized with ammonia and the caprolactam separated. Recently this has been sold for 3.20 mk./kg. to the synthetic fiber plants at Landsberg and Lichtenberg/Berlin.

Igamide A is the standard 6–6 type of nylon (m.p. 250° C.). It is made at Ludwigshafen by reacting 1 mol each of the acid and amine in methanol, centrifuging off the needle crystals, and carrying out the superpolycondensation at 275° C. It is used primarily for injection molding and has good resistance against heat and cold, solvents, and poison gases such as mustard gas. It is essential that the material be practically dry for molding. It is dried to 0.2 percent moisture content at the time of manufacture and it is recommended that the moisture content be less than 0.5 percent when molded. The moldings will withstand boiling water. Typical applications are cable fasteners for airplanes, ignition caps for grenades, combs and buttons.

Igamide B is prepared by polymerization of the caprolactam first at 200° C. to a molecular weight of 5000 and then by superpolymerization to a molecular weight of 12,000 (m.p. 220° C.). It is claimed that the B material is softer and more economical to make than A, and is much more flexible than



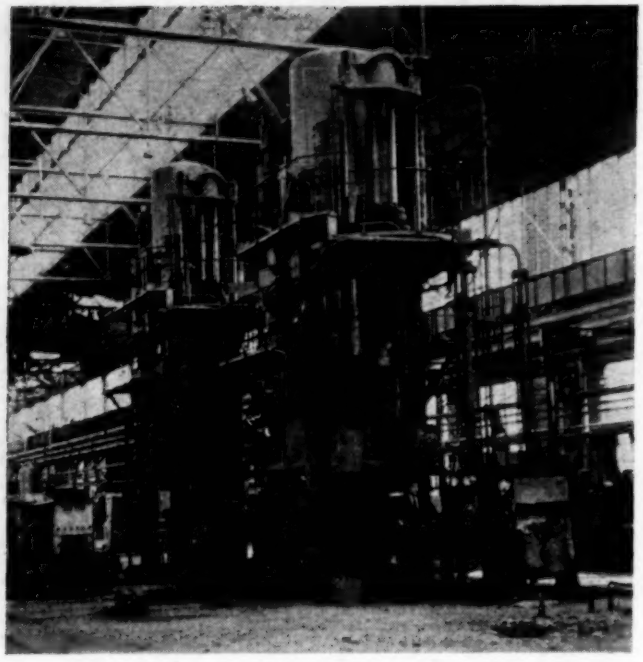
*4—Interior view of the Dynamit AG molding shop at Troisdorf. The missing roof helped to supply proper lighting*

polystyrene. It is the type commonly employed for spinning monofilaments under the name Perlon L; Perlon T is made on a smaller scale with Igamide A. Main production is at Landsberg which used seven machines with 48 spinnerettes to produce 4500 kg. per day. A smaller plant at Lichtenberg made 45 tons per month of bristles and 3000 kg. per month of fiber. A 5 to 10 percent content of residual monomer facilitates the 4:1 stretching of the fiber; this residual caprolactam is washed out later with hot water.

Igamide 6A is the main type used for artificial leather and films. For the former purpose it is generally plasticized with 30 to 35 percent of Dellatol, a mixture of 70 percent toluene butylsulfonamide and 30 percent toluene ethylsulfonamide. Sheets are calendered at 80° C. and press-polished or embossed at 180° C. The other polyamides cannot yet be satisfactorily plasticized and cannot be rolled out into sheets because of the low viscosity of the melts. Films and sheets are also cast from solutions of Igamides 6A and 5A in a mixture of 70 percent ethanol and 30 percent water. A small amount of isododecylphenol is sometimes used as plasticizer. The films are cast on drums at the rate of 160 to 200 meters per hour in thicknesses up to 0.2 mm., usually 0.002 to 0.003 millimeter. These films, called Lyafol, are proof against oil and chlorinated hydrocarbons and were used extensively in Germany for the fabrication of anti-gas capes.

The polyamides can be cross-linked by bifunctional reagents for NH or CO groups, e.g., diisocyanates and formaldehyde. This treatment increases the melting point about 50° C. and improves the water resistance, particularly wet strength under tension. There should be at least one cross linkage per macromolecule. Two percent of Desmodur T (tolylene diisocyanate) gives 2.8 bridges per 2 mols of Igamide 6A. The cross-linking agent is mixed with the polymer on rolls at 60 to 100° C. and is pressed into sheets at 175 to 210° C. for 2 to 3 hours. Aminotriazine-formaldehyde and trimethylolmelamine were tried, but are not as satisfactory as the isocyanates. Diphenyl-4,6,4′-triisocyanate (a nonvolatile solid) reacts more quickly than Desmodur T.

Various dibasic acids have been tried in place of adipic acid used in making Igamide 6A. Type 6P made with $C_7$ acids (pimelic) has better solubility. Type 6K made with $C_8$-$C_9$ acids (cork) is an insoluble polymer. Type 6S made with $C_{10}$ acid (sebacic) has improved water and cold resistance. Ketopimelic acid (acetonediacetic acid) has also been used



*5—Here are two 5000-ton presses in another Dynamit AG building. This German firm had nearly 200 compression presses, but possessed only three injection machines*

on an experimental scale for modifying the standard types of Igamides. Another modification is Igamide 50, composed of 37½ percent A, 37½ percent B and 25 percent diaminodicyclohexylmethane. This type is useful for lacquer purposes because it will remain liquid when cooled to 20 to 50° C. after preparation of solutions at higher temperatures. It has been used as a surface coating on artificial leather to impart scratch resistance.

## Polyurethanes

These polymers are a new development in the plastics field and are not on the market in the United States. The fundamental reaction of an isocyanate with an alcohol to form a urethane was discovered by Wurtz in 1848. The linkage is produced by the transfer of the hydrogen of the hydroxyl to the nitrogen of the isocyanate:

$$R_1N{=}C{=}O + R_2OH \rightarrow R_1NH{-}\underset{\underset{O}{\|}}{C}{-}O{-}R_2$$

Dr. Otto Baeyer, I. G. Farbenindustrie A.-G., Leverkusen, produced polycondensation products by reacting polyisocyanates with polyhydroxy compounds. In general, diisocyanates form linear polyurethanes while tri- and higher compounds produce cross-linked polymers.

The polyisocyanates are called Desmodurs and the polyester (polyhydroxy compounds) are called Desmophens. The compositions of the various types are as follows:

| *Desmodur* | *Chemical composition* |
|---|---|
| A | α-Isocyanyl-ethylbenzene-3-isocyanate |
| C | 1-Chlorophenylene-2,4-diisocyanate |
| DR | Diphenyl-4,6,4′-triisocyanate |
| H | 1,6-Hexanediisocyanate |
| HH | Desmodur H (3 mols) and hexanetriol (1 mol) |
| M | Dicyclohexylmethane-4,4-diisocyanate |
| R | Triphenylmethane-*p*-triisocyanate |
| T | 2,4- (60%) and 2,6- (40%) Tolylenediisocyanate |
| TH | Desmodur T (3 mols) and hexanetriol (1 mol) |
| X | Di-*p*-xylylmethane-4,4-diisocyanate |

| *Desmophen* | |
|---|---|
| 50 | Oxalic acid and trimethylolpropane |
| 200 | Phthalic-adipic acids (1:1) and trimethylolpropane |
| 800 | Phthalic-adipic acid (1:5) and trimethylolpropane |
| 900 | Adipic acid (3 mols) and trimethylolpropane (4.2 mols) |
| 1100 | Adipic acid (3 mols), trimethylolpropane (2 mols) and 1,4-butanediol (2 mols) |
| 1200 | Adipic acid (3 mols), trimethylolpropane (1 mol) and 1,4-butanediol (3 mols) |

Igamide U (m.w. = 10,000) is made by the reaction of 1.004 mols of Desmodur H with 1 mol of 1,4-butanediol in a mixture of 90 parts monochlorobenzene and 10 parts *o*-dichlorobenzene. It is used for injection molding. The melting point is 184° C. with a narrow range between the viscous and liquid states. It is said to be more resistant to solvents, acids and water (2 percent absorption compared with 8 percent for nylon), better in electrical properties and hardness, and easier to mold (lower melting point) than nylon. It has been used for molding condensers for high-frequency electrical equipment. Fibers are produced by spinning from a hot melt and stretching. Approximately 25 tons per month of this Perlon U fiber were used for parachute fabrics and about 1 ton per month for bristles, which are reported to retain their straightness in use better than nylon bristles.

Polyurethane resin was used on a small scale as an adhesive in aircraft construction. It gives a more elastic joint than phenolic resins and is known as Polystal adhesive. It is prepared by mixing 40 parts of Desmophen 900 with 100 parts Desmodur TH. Depending on the room temperature the mixture has a pot life of 1 to 5 hours. Urea can be employed as an accelerator of the curing reaction. Without urea the adhesive requires 10 hr. to cure at room temperature; with it the cure is accomplished in 1 to 2 hours. The accelerator is spread on one side of the wood veneer as a 20 percent solution in water and dried. Moisture must be excluded from the joint during the cure. It is hazardous to use a temperature higher than 60° C. in curing because of the toxicity of the volatile products; most curing is done at room temperature.

A low-density plastic foam is produced by the reaction of Desmophen 900 and Desmodur T and is known as Moltopren. The Desmophen preferable has an acid number of over 30. By the addition of water (not over 2 percent) the specific gravity can be reduced to 0.045. Still lower specific gravity is obtained by the addition of acetone or methylene chloride. A specific gravity of 0.02 can be produced by the use of about 2 percent paraformaldehyde or trioxymethylene as the foaming agent at 100 to 140° C. Strength is improved by the addition of aluminum powder. Higher pressures also give a finer pore structure and improved strength. The addition of about 15 percent trichlorethyl phosphate (Cetamoll Q) reduced the flammability of the foam.

A typical formula with costs of raw materials for Moltopren is the following:

| | *Mk.* |
|---|---|
| 1.000 kg. Desmophen 900 | 2.75 |
| 0.200 kg. Cetamoll Q | 0.55 |
| 0.150 kg. Methylene chloride | 0.09 |
| 0.002 kg. Mowilith 30 in acetone (30% sol.) | 0.01 |
| 0.500 kg. Desmodur T | 2.75 |
| 1.7 kg. Foam (dry) | 6.15 |

Moltopren plastic foam of 0.10 specific gravity is reported to have a compressive strength of 5 to 10 kg./cm.² and good impact resistance. It was delivered to aircraft manufacturers in block form, approximately 700 by 700 by 100 mm., and was used as a core material with facings of metal or plywood

in the construction of wings and stabilizers for airplanes. It has been employed on submarines for sound insulation and on tanks for heat insulation.

The polyurethanes have also proved to be useful as coatings for wood, rubber, leather, paper and the like. The coatings are said to be glossy and weather resistant, and to have good electrical properties and very low permeability to gases. Paper impregnated with this type of plastic is claimed to provide excellent protection against mustard gas.

In general, the polyisocyanates react with compounds having a hydrogen replaceable by sodium, e.g., OH, $NH_2$, $SO_2$-$NH_2$, COOH, etc. Therefore, they have uses other than in the manufacture of polyurethanes. Since hides have amino groups with which the diisocyanates can combine, they have been employed in place of natural tannins in leather manufacture, requiring only 7 hr. instead of 80 to 100 hr. for the tanning operation. Likewise, acetate rayon can be made resistant to melting under a hot iron by treatment with a diisocyanate. Desmodur R has been found to be suitable for attaching rubber to steel tank treads, yielding bonds which are stronger than the rubber itself. Experiments have also demonstrated that 2 percent of Desmodur R mixed with synthetic rubber or impregnated on tire cords provides an excellent bond between the two materials without addition of natural rubber.

## Polyvinyl ethers

Another type of plastic produced in Germany during the war but not in the United States is the polyvinyl ether group, designated by the trade name Igevin. These polymers are used in large quantities as lacquer constituents, adhesives and impregnating agents. The ethers are made at Ludwigshafen by continuous-process addition of alcohols to acetylene, using potassium hydroxide catalyst. The yield is 90 to 95 percent based on either acetylene or alcohol; the output is approximately 600 tons per month. Block polymerization using boron trifluoride catalyst is commonly employed in making the polymer. It is not possible to polymerize the vinyl ethers in aqueous emulsions because the ethers are easily saponified. Only polymers of low *K* value are obtained by polymerization in solution.

The compositions, tonnages produced in 1942 and cost and selling price per kilogram of the various polyvinyl ethers made at Ludwigshafen are as follows:

| *Igevin type* | *Composition* | *1942 production* | *Cost* | *Selling price* |
|---|---|---|---|---|
| | | *tons* | *mk./kg.* | *mk./kg.* |
| M 40 | Vinyl methyl ether | 159 | 1.03 | 1.70 |
| A 50 | Vinyl ethyl ether | 254 | 1.27 | 1.95 |
| A 25 | Vinyl ethyl ether | 536 | 1.19 | .. |
| J 60 | Vinyl isobutyl ether | 506 | 1.04 | 1.85 |
| J 30 | Vinyl isobutyl ether | 1058 | 0.96 | .. |
| J 20 | Vinyl isobutyl ether | 68 | 0.97 | .. |
| Z | Vinyl beta-decalol ether | 147 | 1.76 | .. |
| AZ 28 | Vinyl ethyl ether 20<br>Vinyl decalol ether 80 | 7 | 1.68 | .. |
| ZJR | Vinyl isobutyl ether 20<br>Vinyl decalol ether 80 | 273 | 1.20 | .. |
| ZJ | Vinyl isobutyl ether 40<br>Vinyl decalol ether 60 | 100 | 1.43 | 2.95 |

The numbers in the type designation indicate the *K* value of the polymer. Other polyvinyl ethers were developed and used during the war. These include the following types:

***6—A street scene in Wiesbaden, taken from a hotel bedroom. Note the bathtub in the center of this picture***

| *Type* | *Composition* | |
|---|---|---|
| I. G. Wachs V | Vinyl octadecyl ether | |
| Densodrin V | Vinyl ether of hydrogenated sperm oil | |
| Densodrin H | Densodrin V plus 30 percent rosin | |
| Densodrin W | Vinyl ether of hydrogenated sperm oil | 80 |
| | Vinyl ether of coconut oil | 20 |
| Bindemittel Li 10 | Vinyl methyl ether | 66 |
| | Divinyl diglycol ether | 5.5 |
| | Vinyl tallol ether | 28.5 |

Polyvinyl isobutyl ether is used as the base of adhesives made at Uerdingen and designated by the trade name Cosal. They are generally supplied as solutions in benzine, acetone or esters. Their principal uses are for the installation of upholstery in motor cars, sealing cellophane and other foils, and in cementing materials to glass and metals.

The solution polymers are used, sometimes in combination with other resins, to impregnate or coat paper and textiles. In the latter field the polyvinyl methyl ether, which is the only one soluble in water, is called Appretan WL. The production of polyvinyl isobutyl ether as an 80 percent solution in benzine in 1942 was 266 tons at a cost of 0.98 mk./kg.; 92 tons of polyvinyl methyl ether as a 70 percent solution in methyl acetate were produced the same year at a cost of 0.92 mk./kg. The latter product is called Plastomoll SW. The standard types of Igevin polymers sold for lacquer purposes are as follows:

| *Type* | *Concentration* |
|---|---|
| M 40 | 50 and 70 |
| A 50 | 50 and 70 |
| A 25 | ..... |
| J 60 | 70 and 80 |

## Polyacrylates

The production of acrylic polymers (Acronals) was carried on in Germany by I. G. Farbenindustrie A.-G. at Ludwigshafen: the methacrylic polymers and copolymers (Plexigum and Plexiglas) were produced by Rohm and Haas A.-G. at Darmstadt and Mittenwald. The polyacrylates are made

TABLE I—1942 PRODUCTION AT LUDWIGSHAFEN

| *Acronal type* | *Composition* | | *1942 production* | *Cost* | *Selling price* |
|---|---|---|---|---|---|
| | | | *tons* | *mk./kg.* | *mk./kg.* |
| | MONOMERS | | | | |
| ..... | Acrylic acid | | 570 | 1.41 | 2.20 |
| ..... | Acrylonitrile | | 1014 | 1.77 | 2.50 |
| ..... | Methyl acrylate | | 844 | 1.50 | 2.40 |
| ..... | Ethyl acrylate | | 2004 | 1.75 | 2.80 |
| ..... | Butyl acrylate | | 763 | 1.89 | 3.20 |
| ..... | Methyl methacrylate | | 27 | 2.43 | .. |
| | SOLIDS | | | | |
| I | Polymethyl acrylate | | 32 | 2.32 | 5.00 |
| II | Polyethyl acrylate | | 44 | 2.64 | 5.80 |
| IV | Polybutyl acrylate | | 4 | 2.78 | 6.10 |
| | EMULSIONS | | | | |
| L 100 | Polymethyl acrylate | | | | |
| | 25 percent conc. | | 147 | 0.48 | .. |
| | 40 percent conc. | | 184 | 0.76 | .. |
| L 200 | Polyethyl acrylate | | | | |
| | 25 percent conc. | | 423 | 0.55 | .. |
| | 40 percent conc. | | 922 | 0.86 | .. |
| L 400 | Polybutyl acrylate | | | | |
| | 25 percent conc. | | 9 | 0.59 | .. |
| | 40 percent conc. | | 10 | 0.94 | .. |
| 250 D | Methyl acrylate | 80 | 174 | 0.74 | .. |
| (40 percent) | Vinyl benzoate | 20 | | | |
| | Acrylic acid | 1 | | | |
| 400 D | Methyl acrylate | 66 | 530 | 0.68 | .. |
| (40 percent) | Vinyl isobutyl ether | 20 | | | |
| | Styrene | 12 | | | |
| | Acrylic acid | 2 | | | |
| 550 D | Methyl acrylate | 27 | 719 | 0.75 | .. |
| (50 percent) | Vinyl isobutyl ether | 27 | | | |
| | Acrylic acid | 1 | | | |
| 450 D | Ethyl acrylate | 66 | 2961 | 0.75 | .. |
| (40 percent) | Vinyl isobutyl ether | 20 | | | |
| | Styrene | 12 | | | |
| | Acrylic acid | 2 | | | |
| 600 D | Ethyl acrylate | 76 | 169 | 0.78 | .. |
| (40 percent) | Vinyl isobutyl ether | 22 | | | |
| | Acrylic acid | 2 | | | |
| 300 D | Butyl acrylate | 1 | 23 | 0.68 | .. |
| (50 percent) | Vinyl acetate | 1 | | | |
| | Vinyl chloride | 1 | | | |
| 500 D | Butyl acrylate | 49 | 2360 | 0.89 | .. |
| (50 percent) | Vinyl acetate | 49 | | | |
| | Acrylic acid | 2 | | | |
| | SOLUTIONS | | | | |
| I | Polymethyl acrylate 27 percent in ethyl acetate | | 249 | 0.88 | .. |
| I | Polymethyl acrylate 40 percent in toluene | | 21 | 1.00 | .. |
| II | Polyethyl acrylate 30 percent in ethyl acetate | | 372 | 1.00 | .. |
| II | Polyethyl acrylate 60 percent in toluene | | 568 | 1.42 | .. |
| Latekoll S | Polyacrylic acid (30 percent) | | 3 | 0.58 | .. |
| Latekoll N | Sodium polyacrylate (25 percent) | | 71 | 0.53 | .. |
| Latekoll A | Ammonium polyacrylate (10 percent) | | 86 | 0.26 | .. |

in emulsions of 25 to 50 percent solids content at the rate of 500 to 600 tons per month and in solutions of 20 to 50 percent solids content at the rate of 50 to 125 tons per month. Methyl methacrylate polymer was made at the rate of 300 to 320 tons per month and copolymers at the rate of 40 to 60 tons per month in 1943.

The compositions, tonnages produced in 1942 and cost and selling price per kilogram of the acrylic raw materials and polymers produced at Ludwigshafen are given in Table I.

The methyl and ethyl acrylate monomers are made continuously by interaction of ethylene cyanhydrin, methyl alcohol and sulfuric acid. The butyl ester is prepared by first making acrylic acid from ethylene cyanhydrin and then esterifying with butanol.

The acrylate polymers cannot be prepared conveniently by block polymerization because of the violence of the exothermic reaction. They are generally made as aqueous emulsions, using 0.05 percent of potassium persulfate or hydrogen peroxide as catalyst. The termination of the polymerization is controlled chiefly by viscosity or solids content. To obtain the solid resin a 0.5 to 1 percent solution of aluminum chloride is mixed with the emulsion to precipitate the polymer. Formic acid is used as the precipitating agent when the presence of an electrolyte in the polymer would be objectionable; the formic acid is decomposed to volatile gases during the subsequent rolling and drying operations.

For solution polymerization more powerful stirring motors are required because of the higher viscosities of the final products. The solvents commonly employed are ethyl acetate, benzine, benzene and toluene. The catalyst used is 0.1 to 0.5 percent of benzoyl peroxide, based on monomer. The *K* value is controlled in some cases by the addition of aldehydes which react with end groups and terminate chain reaction. Propyl and butyl aldehydes are used in amounts varying from 0.008 to 0.015 percent; acetaldehyde is not used because of handling difficulties. Mixed polymers containing acrylic acid are not made by solution polymerization because it tends to form polyacrylic acid which is not compatible with the polyesters.

Methyl methacrylate monomer is produced by Rohm and Haas by the batch conversion of acetonecyanhydrin to the methacrylate ester by treatment with sulfuric acid and methyl alcohol. The yield of pure ester is said to be 80 to 82 percent based on the cyanhydrin. Butyl methacrylate is made by a similar process, but is more difficult to make because dibutyl ether which accelerates the polymerization reaction is formed as a byproduct. The butyl ester is vacuum distilled from phenol to avoid excessive formation of the ether.

The Rohm and Haas firm is the sole producer of cast methyl methacrylate sheet (Plexiglas) in Germany. Approximately 58,000 sq. meters were made per month at peak production; thicknesses ranged from 0.5 to 50 mm., being about 6 to 7 mm. for aircraft enclosures in 1944. The peak production of 12 to 15 tons per month of molding powder was reached in 1943; that of dental powder was 15 tons per month in 1944.

The cast methyl methacrylate sheets are made by the usual process, using molds made of plate glass with edges sealed with paper strips and 0.02 percent benzoyl peroxide catalyst. The aircraft grade is made with 4 percent of dibutyl phthalate as a plasticizer. Five to 10 percent of the sheet produced was made without plasticizer for special optical purposes. The polymer is said to have a molecular weight of 1 to 1.5 million, as determined in chloroform solution. Before 1937, Plexiglas was made by copolymerization with 4 percent of butyl acrylate, but this product was found to be no better than the plasticized material.

*7—The Raschig plant at Ludwigshafen. Phenol resin plant was destroyed; molding powder production unit was left intact*

The Plexiglas used for forming aircraft windshields is annealed by heating in an oven. Paper is applied to the sheets with gelatin adhesive for protection against scratches. Some firms had experimented with the application of silicon dioxide and other inorganic coatings for improving scratch resistance without success. Rohm and Haas had prepared allyl methacrylate, vinyl methacrylate and methylene-*bis*-methacrylic acid amide in a search for materials less easily scratched, but these polymers are brittle. Copolymers of methyl methacrylate with styrene were prepared to obtain products having a range of refractive index for use in making lenses.

The molding powders (Plexigum M 263) are made from granular polymer prepared with 0.5 percent of potassium persulfate as catalyst and 0.5 percent of a copolymer of 70 parts methacrylic acid and 30 parts methyl methacrylate as a granulating agent. Alternatively, finely powdered magnesium carbonate is employed for this latter purpose. For fine granules 18 g. are used per liter of water; for large granules 8 to 10 grams. The magnesium carbonate is removed from the polymer by treatment with sulfuric acid; insoluble silicates in the granulating agent lead to haze. The molecular weight of the granular polymer for molding powders and dentures is in the range 80,000 to 140,000; a 20 percent reduction in molecular weight occurs on the rolls on which the polymer is heated and rolled in the preparation of injection molding powders. These are used for the same types of applications as in the United States, e.g., electrical parts, cover lights for aircraft, compasses for submarines and the like.

Emulsion copolymers of methacrylates and acrylates were produced during the war for use in lacquers (30 to 50 tons per month) and adhesives (1 ton per month). The following two types are the most important ones:

| *Type* | *Composition* | |
|---|---|---|
| Plexigum B 50 | Methyl methacrylate | 50 |
| | Ethyl acrylate | 50 |
| Plexigum 315 | Methyl methacrylate | 60 |
| | Ethyl acrylate | 20 |
| | Butyl acrylate | 20 |

The latter type was produced during the war because of a shortage of ethyl acrylate. The polymerization process is the same as for Plexigum 263. A special emulsion polymer of methyl methacrylate, Plexigum 264, of lower molecular weight (40,000 to 60,000) for use in wartime lacquers is made using 8 to 10 g. of magnesium carbonate per liter of water. These lacquers are used in coating metal and wood and on food containers. They are not suitable for use in contact with acid products.

Rohagit S is an alkali-soluble copolymer consisting of 65 percent methacrylic acid and 35 percent methyl methacrylate. Polymerization is accomplished with benzoyl peroxide as catalyst, using 0.2 percent for high molecular weight and 1.0 percent for low molecular weight. It is used in concentrations of 0.5 to 1.0 percent as a thickening agent for emulsions and dispersions of resins, particularly polyacrylates and polyvinyl acetates. It also has applications in stiffening fabrics, impregnation, coatings, adhesives, and as an emulsifying agent for lubricating oils. It was used as an adhesive on envelopes during the war, but is not especially suitable for this purpose. The output of Rohagit S was approximately 8 tons per month.

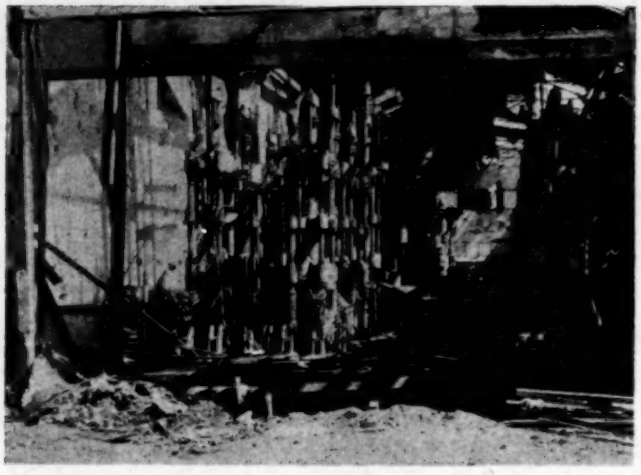
## Polyvinyl carbazole

Polyvinyl carbazole (Luvican) was developed by I. G. Farbenindustrie A.-G. at Ludwigshafen as a mica substitute and a synthetic asbestos. It has not proved to be satisfactory for other than a few special purposes because of its brittleness and did not have sufficient importance to warrant work on the synthesis of carbazole. Production has been limited to approximately 5 tons per month. The 1942 production data are as follows:

| *Type* | *Composition* | | *1942 production* | *Cost* | *Selling price* |
|---|---|---|---|---|---|
| | | | *tons* | *mk./kg.* | *mk./kg.* |
| .... | N-Vinyl carbazole | | 27 | 1.20 | .. |
| M 150 | Polyvinyl carbazole | | 25 | 2.34 | 4.50 |
| M 125 | Vinyl carbazole | 85 | 4 | 2.27 | 4.50 |
| | Styrene | 15 | | | |
| M 100 | Vinyl carbazole | 70 | .. | .. | .. |
| | Styrene | 30 | | | |

Vinyl carbazole is produced by addition of carbazole (100) to acetylene (16) in hexahydroxylene (100) using potassium hydroxide (3.2) and zinc oxide (1.0) as catalysts. The yield is in the range 68 to 72 percent. It is polymerized in a mixture of 750 kg. vinyl carbazole, 112 kg. sodium chloride, 75 kg. sodium hydroxide (50 percent), 13 kg. sodium dichromate containing sufficient caustic to produce the yellow color of sodium chromate, and water to make up to 1500 kilograms.

In general, Luvican is used for electrical purposes, particularly for high-frequency insulation. Its electrical properties are as good as those of polystyrene, its softening point (150° C. Martens test) is much higher, but its impact strength and



*8—Molding shop of Presswerk AG. at Essen. This firm specialized in the production of various plastic bearings*

other mechanical properties are inferior. Its water resistance is good. The molecular weight of the polymer is not high ($K$ = 40 to 50). The base resin is silver-brown and coloring is difficult. The temperature required for injection molding Luvican is 220 to 230° C. To obtain a tougher product it is oriented by extrusion at 220° C. through a Strangpresse (screw type) and broken up into coarse fiber-like pieces. These can be compression-molded while still retaining their orientation and yield a comparatively strong molding. By using a solution of the polymer in tetrahydrofurane it is possible to cast thin foils which are used as substitutes for mica in condenser dielectrics.

## Polyester elastomers

These plastics are rubberlike products made with polybasic acids and polyhydroxy alcohols and designated as I-Gummi and I-Rubber. They are similar to Paracon resins made in the United States. They were developed at Ludwigshafen particularly for lining the inside of gasoline tanks on aircraft. Harz G 215 was made with 1,4-butanediol and adipic acid. The Luftwaffe used gasoline containing 2 percent cresol or phenol and the tank linings had to be resistant to these liquids.

Some types of I-Gummi are made with 1 mol of trimethylolpropane to 26 mols of ethylene glycol; the trihydroxy compound serves as a cross-linking agent. A recently developed product is made with 100 mols adipic acid, 93 mols ethylene glycol and 7 mols tetramethylenediamine. This polyester is then crosslinked by means of a polyisocyanate made up of 7 mols hexanediisocyanate and 9 mols tolylenediisocyanate. The resulting product, called IN-Gummi, has a tensile strength of 292 kg./cm.$^2$ and an elongation of 850 percent. It also has a specially high notch stability.

An even stronger product is made by the use of diisocyanates containing a nitro group, for example, nitrobenzidindiisocyanate. It is claimed that this product has a tensile strength of 188 kg./cm.$^2$ and an elongation of 1200 percent. The notch stability is about 30 kg., comparable to natural rubber. It can be compounded with 90 percent of talc and chalk, whereas ordinary types of I-Gummi will only take 30 percent filler. Sulfone and halogen groups do not have this effect.

Bindemittel Li 160, used as a substitute for linseed oil in the linoleum industry, is a product of this same general type. The monomer is the ester prepared with adipic acid and trimethylolpropane. In 1941 the production of this material was 888 tons at 1.09 mk./kg. Its absorptive capacity for fillers, such as cork meal, woodflour, mineral pigments and the like, is greater than that of the linseed product used in making linoleum.

## Polyvinyl acetate

Vinyl acetate monomer is made by the I. G. Farbenindustrie A.-G. at Hochst and by the Dr. Alexander Wacker G. m. b. H. at Burghausen. It is produced by the Wacker firm by the addition of acetic acid to acetylene, using as catalyst activated wood charcoal (100 parts) impregnated with zinc acetate (70 parts). The yield is 95 to 97 percent of the acetic acid consumed and 91 to 92 percent of the acetylene. The normal output was 200 tons per month at a cost of about 0.45 mk./kg. At Hochst the output was 1000 tons per month.

Polymerization of the vinyl acetate is accomplished at Burghausen by four methods: block, solution, emulsion and suspension. Block polymerization is conducted in a heated kettle with reflux and stirrer. The polymer is discharged into metal trays, cooled and ground to desired size. Benzoyl peroxide (0.08%) is used as the catalyst and acetaldehyde is used to control the degree of polymerization. The different grades made and the proportions of acetaldehyde employed are shown in the following table. The type numbers are viscosity values (sec.) in 20 percent solution.

| *Vinnapas no.* | *Monomer* | *Acetaldehyde* |
|---|---|---|
| | *kg.* | *kg.* |
| B 5 | 1000 | 30 |
| B 17 | 1000 | 17 |
| B 60 | 600 | 6 |
| B 100 | 500 | 5 |
| B 1000 | 400 | 3 |
| B 10,000 | 1000 | .. |

Production was about 100 tons per month.

Solution polymerization at Burghausen is carried out chiefly in ethyl alcohol or ethyl acetate, although toluene was used in prewar practice. Butyl acetate and acetone are also used occasionally. Only about 0.01 percent benzoyl peroxide catalyst is employed. The degree of polymerization depends upon the solvent, as indicated by the following values:

| *Solvent* | *Viscosity of polymer solution* |
|---|---|
| Acetone | 10–12 |
| Ethyl alcohol | 17 |
| Ethyl acetate | 80–110 |
| Toluene | 60 |

Production was about 100 tons per month.

Emulsion polymerization is conducted with polyvinyl alcohol as the emulsifying agent and hydrogen peroxide as the catalyst. The stirrer is kept running continuously at about 50 r.p.m. Production was about 300 tons per month.

Suspension polymerization is accomplished in water with 0.1 percent of benzoyl peroxide as catalyst. Acetaldehyde is used to control the degree of polymerization. The stirrer is run at 120 r.p.m. until refluxing starts, whereupon the stirrer is stopped and the polymerization allowed to proceed. After about 1½ hr. a solution of polyvinyl alcohol is added and the polymer separates into spheres of 0.1 to 1 mm. diameter. Polymerization continues for another 4 hr. and the granules grow in size. The following grades are made:

| *Vinnapas (suspension-polymer)* | *Acetaldehyde per 1000 kg. monomer* |
|---|---|
| | *kg.* |
| UW 10 | 2.2–2.5 |
| UW 20 | 1.6–1.75 |
| UW 50 | 0.9–0.95 |
| UW 100 | 0.60 |
| UW 200 | 0.45 |
| UW 10,000 | ..... |

The solution polymers are used for the production of polyvinyl alcohol.

At Hochst the output of solid Mowilith was about 150 tons per month; of Mowilith solutions about 80 tons per month; and of Mowilith emulsions (50 percent solids) about 1000 tons per month.

The composition, output and costs of some of the types produced in 1942 at Hochst are as follows:

| *Type* | *Composition* | | *1942 production* | *Cost* |
|---|---|---|---|---|
| | | | *tons* | *mk./kg.* |
| Appretan EMI | Polyvinyl acetate | 94.8 | 4763 | 0.52 |
| (50 percent) | Polyvinyl alcohol | 5.2 | | |
| Mowilith D 32 | Polyvinyl acetate | 38.7 | 4124 | 0.62 |
| (58 percent) | Polyvinyl alcohol | 1.9 | | |
| | Tricresyl phosphate | 11.6 | | |
| | Dibutyl phthalate | 7.7 | | |
| | Alcohol | 3.3 | | |
| | Water | 36.8 | | |
| Mowilith D 32 | Polyvinyl acetate | 44.0 | 3313 | 0.69 |
| (66 percent) | Polyvinyl alcohol | 1.2 | | |
| | Octylphenyldi-glycolether | 0.4 | | |
| | Tricresyl phosphate | 13.3 | | |
| | Dibutyl phthalate | 8.9 | | |
| | Alcohol | 3.9 | | |
| | Water | 28.3 | | |
| Appretan EMW | Vinyl acetate | 70 | 349 | 0.52 |
| (48 percent) | Vinyl chloride | 30 | | |

The most important uses for polyvinyl acetate are as adhesives for leather, paper and textiles, and as textile sizes. The adhesion strength decreases as the molecular weight increases above about 5000 to 10,000. The solutions are used in admixture with 0.5 to 2 parts nitrocellulose in the production of coatings for wood and metals to improve adhesion and fastness to light. Block-polymerized polyvinyl acetate is used for making molding powders and is combined with plasticizer for making sheets for safety glass manufacture. It is not used for making foils because of its low melting point.

The polyvinyl acetates are not as resistant to water as the polyacrylates, nor can their properties be varied as readily by copolymerization. Present prices greatly favor the former, being about 1.5 mk./kg. for Mowilith and 4.5 mk./kg. for Acronals. However, if the Reppe process for synthesizing acrylic acid from acetylene, carbon monoxide and water gives satisfactory yields, the costs may be about equal.

## Polyvinyl alcohol

Two types of polyvinyl alcohol (Polyviol) are made, starting from the block (B) and suspension (U) polymerized polyvinyl acetate, respectively. The B type material gives a polymer more soluble in water. Each is saponified in a methanol solution of sodium methylate. The saponification value is normally 100 but when the polymer is to be used for belts the saponification value is 23 to 35. When the material is to be used for electrical purposes the sodium acetate is extracted with ethyl alcohol. The polymer designated as U.K.B. 100/100 refers to Ungeestered Knieder B-type polyvinyl acetate of 100 sec. viscosity completely saponified. Production of Polyviol was approximately 30 tons per month.

The greatest part of the polyvinyl alcohol is used for making emulsions of polyvinyl acetate. Two percent of Polyviol is commonly employed for this purpose. For an emulsifying agent in the preparation of polyvinyl chloride, 0.25 percent of Polyviol is used.

## Polyvinyl acetals

The acetal polymers are prepared by hydrolyzing polyvinyl acetate with sulfuric or glacial acetic acid and reacting the polyvinyl alcohol with the appropriate aldehyde. Production was relatively small, about 5 tons per month at Burghausen (Pioloform) and 5 tons per month at Ludwigshafen (Mowital).

Mowital B and Pioloform B, the butyral derivatives, are used as the interlayer for safety glass. Pioloform B has a hydroxyl content of 20 to 24 percent and an acetate content of 4 to 6 percent. Dibutyl adipate is used as a plasticizer. To improve adhesion to glass the acetal sheet is run through a bath consisting of 70 parts benzyl alcohol, 30 parts triacetin and 2 parts tetraethylsilicate just prior to assembly with the glass faces. The assembled safety glass is pressed between rolls and heated under pressure for 20 min. at 130° C. The temperature at which the safety glass is penetrated by a 50-mm. diameter steel ball dropped 2 m. was −40° C. without this treatment and −70° C. with it.

Pioloform A, the acetaldehyde derivative, is used in lacquers and for stiffening straw hats. The product made with equal parts of acetaldehyde and diethyl acetaldehyde is said to be better for the latter purpose. Mowital A is also employed in the fabrication of tubing resistant to gasoline and benzene.

Mowital O is made from polyvinyl alcohol and cyclohexanone. It is used for coating wires, similarly to Formex in this country. The formaldehyde derivative is also made on a small scale.

## Polyisobutylene

Liquid isobutylene is polymerized in liquid ethylene solution at −100° C. with boron trifluoride as a catalyst to get the highest molecular weight products. The molecular weight may be controlled by the addition of *n*-butylene, the more added the lower the molecular weight. Production of polyisobutylene, known as Oppanol B, at Oppau was 400 tons per month.

Oppanol B products are graded according to molecular weight, i.e., B 3 has a molecular weight of 3000 and B 200 a molecular weight of 200,000. The chief grades made are 3, 50, 100, 150 and 200. The latter is actually a mixture of polymers of molecular weights between 150,000 and 200,000. It has better toughness than the 80,000 molecular weight polyisobutylene commonly used in the United States, but is more difficult to work on the machines. It is the grade preferred by cable manufacturers.

Uses of Oppanol B include gas-protective equipment coated by solvent (benzene) or by calendering on cloth, addition to Buna S to facilitate milling, and fabrication of aircraft oxygen tubing. The latter application is especially dependent upon the low-temperature flexibility of polyisobutylene which is claimed to be superior to that of polyvinyl chloride. Pipes and tanks can be lined by pneumatically expanding an Oppanol B tubing into a pipe previously coated on the inside

with an adhesive consisting of a 40 percent solution of Oppanol B in monomeric styrene containing benzoyl peroxide catalyst. Extruded B 200 tubing is used for inner linings of pipes for handling beer and foodstuffs; no plasticizer or softener is used in such tubing.

Limitations of paraffin, with respect to low melting point and friability, in waterproofing paper were overcome by the use of 5 to 20 percent of Oppanol B mixed with the wax. The Oppanol is milled into the paraffin to make a master batch which is added in the desired quantity to molten wax and melt coated on the paper. Adhesion can be improved through the addition of polyvinyl isobutyl ether.

Oppanol B can be mixed with up to 10 parts filler, such as carbon black, silica, ground slate and asbestos. These compositions find application as gaskets, tank linings and caulking compounds. Oppanol ORG is a mixture of polyisobutylene, carbon and graphite, used in sheet form as flashings in building construction to protect against ground water and for flexible joints in concrete. Another product used for this same purpose is Dynagen, made at Troisdorf and consisting of 20 parts Oppanol B 200, 5 parts montan wax, 55 parts talc and 20 parts carbon black. These sheets are made on calender rolls in thickness of 1 to 2 mm.; monthly production was 20 to 50 tons.

Oppanol O consists of 90 percent polyisobutylene and 10 percent polystyrene. It is made into foils and used for electrical insulation. Oppanol U is an experimental product made by copolymerization of isobutylene with isoprene or butadiene. Oppanol C is an exception in the Oppanol series of polymers, in that it is not a polyisobutylene product but is polyvinyl isobutyl ether.

## Polyethyleneimine

Polymin P was made at Ludwigshafen by polymerization of ethyleneimine to the extent of 4 tons per month for use as a paper impregnant. It greatly improves the wet strength and scuff resistance of soft crepe paper. It does not detract from the absorbent qualities, hence it is used for towels, bandages and shoe insoles. A content of 1 to 2 percent based on the dry pulp is employed. The Polymin P is a brownish viscous liquid and is added to the beater as a 50 percent aqueous solution. It is selectively absorbed on the pulp in the same manner as direct dyes. Its effectiveness has warranted its use in spite of its high price, 6 mk./kg.

## Phenolic resins

The annual production of phenolic molding compounds was approximately 7000 tons by the Albert firm, 6500 tons by Dynamit A.-G. (Trolitan), and 4800 tons by Raschig G. m. b. H. (Resinol). (No information is yet available regarding the production figures for Bakelite G. m. b. H. and Nowack A.-G.)

During the war special phenolic compounds were made for molding fuse parts for the German Army. These had the following compositions:

| *Ingredients* | *Type B* | *Type N* | *Type C* |
|---|---|---|---|
| | *percent* | *percent* | *percent* |
| Phenolic resin | 32.5 | 33.0 | 33.0 |
| Hexamethylenetetramine | 6.2 | 6.4 | 6.4 |
| Woodflour | 11.1 | 14.9 | 14.9 |
| Magnesium oxide | 0.7 | 0.5 | 0.5 |
| Magnesium stearate | 1.3 | 0.8 | 0.8 |
| Calcium fluoride | 48.2 | .. | .. |
| Bronzite | .. | 44.4 | .. |
| Slate dust | .. | .. | 44.4 |

The bronzite was stated to be an iron-aluminum silicate. The manufacturers of the compounds and the molders reported that these special materials are very difficult to prepare and mold because of the abrasive nature of the mineral fillers. Their use was probably based on excellent dimensional stability under various conditions of temperature and humidity.

Because of a shortage of phenolic resin in Germany during the war, a new type of molding compound containing only 20 to 25 percent resin was established in January 1943. Known as type 41 it contained woodflour as a filler. Its properties are specified as follows:

| | |
|---|---|
| Flexural strength, minimum..... | 600 kg./cm.$^2$ |
| Impact strength unnotched, minimum.. | 5.0 cm. kg./cm.$^2$ |
| Impact strength notched, minimum.... | 3.5 cm. kg./cm.$^2$ |
| Heat stability, Martens, minimum..... | 90° C. |
| Density of molding, maximum..... | 1.45 kg./dm.$^3$ |
| Water absorption, 4 days, maximum... | 7 mg./cm.$^2$ |

The use of this material was mandatory for the following applications:

Grips for bayonets, revolvers, rifles, and flare pistols.
Stocks for automatic rifles.
Guards for rifles.
Oil bottles for infantry use.
Closures for shells.
Collars for flash-reducers on guns.
Covers for smoke boxes.
Binocular cases.
Handles, knobs and wheels for artillery.
Grips for hand lamps.
Switches and cover plates.
Casters for trucks.
Electric horns.

The following prices were established in November 1942 for phenol molding compounds:

| *Approximate resin content* | *Price* |
|---|---|
| *percent* | *mk./kg.* |
| 35 | 2.75 |
| 40 | 3.50 |
| 45 | 4.15 |
| 50 | 4.50 |

A new technique for preparing molding compounds, superior to the common kneading and rolling method in labor requirement, was developed in Germany during the war. This involves the use of an Eirich mixer which is an edge runner mill in which the mixing wheels are arranged in two pairs rotating in one direction while the pan rotates in the opposite direction. The runners are fitted with ploughs and side scrapers to assist in the discharge of the materials through an opening in the bottom. The standard Eirich mixer is heated by steam or hot water circulating in a jacket, but this method sometimes leads to local curing and sticking. Albert G. m. b. H. prefers to inject high-pressure steam at 300° C. When the molding compound temperature reaches 70° C., the steam is cut off and mixing is continued.

Methods are also under development in Germany for preparation of molding compounds by a continuous process. The Raschig process involves feeding the blended material by screw conveyor to the center of two mixing rolls. The front roll operates at a faster speed and higher temperature than the back roll. A sheet is formed on the front roll and travels toward both sides. There it is cut off by cutting wheels and drops on to a belt which takes it to a grinder. Another continuous process for making molding compounds is based on a screw-type extrusion machine developed by

Nowack A.-G. Special provision has to be made for cooling the extrusion screw to avoid curing and sticking of the resin.

Albert G. m. b. H. made the following types of phenolic resins:

| | *Type D.A. (Novolak)* | *Type F.H. (Novolak)* | *Ammonia-free type (Resole)* |
|---|---|---|---|
| Phenol | 1 mol | 1 mol | 1 mol |
| Formaldehyde | 0.8 mol | 0.9 mol | 1.5 mol |
| Catalyst (based on phenol) | 1 % HCl | 1 % oxalic acid | 10 % $Ba(OH)_2 \cdot 10H_2O$ |

Examples of novolaks and resoles made by Dynamit A.-G. are as follows:

| *Ingredient* | *Type T4 (Novolak)* | *Type T3 (Resole)* |
|---|---|---|
| Phenol, kg. | 650 | 1500 |
| Formaldehyde (30 percent), kg. | 585 | 1350 |
| Oxalic acid, kg. | 3.25 | .. |
| Ammonia (25 percent), kg. | .. | 75 |

A special type of resole, Type T21A, was made during the war for molding materials used in contact with explosives. This resole is made by an acid-alkali process, using oxalic acid for the acid condensation and magnesia for the alkaline stage.

The basic formulas for the molding compounds produced by Dynamit A.-G. are as follows:

| *Ingredient* | *Tolitan S* | *Trolitan T* | *Dynal* |
|---|---|---|---|
| | *parts* | *parts* | *parts* |
| Novolak resin | 400 | 375 | 605 |
| Hexamethylenetetramine | 60 | 65 | 135 |
| Woodflour | 550 | ... | ... |
| Macerated fabric | ... | 550 | ... |
| Soda pulp | ... | ... | 1610 |

The following information was obtained regarding the costs of raw materials used by Dynamit A.-G. in the manufacture of phenolic resins:

| *Material* | *Cost* |
|---|---|
| | *mk./kg.* |
| Phenol, synthetic | 1.0 |
| Phenol, crude<br>45–55 percent phenol, 30 percent cresol (1/3 meta), 12 percent xylenol, 0.05 percent pyridine | 0.6 |
| Cresol, DAB 4M1<br>28 to 30 percent each of meta and para, rest ortho and xylenols | 0.32 |
| Cresol, DAB 4M2<br>30 to 35 percent each of meta and para | 0.34 |
| Cresol, DAB 4B1<br>38 to 42 percent each of meta and para | 0.36 |
| Cresol, DAB 4B2<br>43 to 45 percent each of meta and para | 0.40 |
| Cresol, DAB 4B6<br>50 percent meta-cresol, 50 percent para-cresol | 0.45 |
| Formaldehyde (30 percent) | 0.19 |

Phenolic resins (Luphen) for use in protective coatings were made by I. G. Farbenindustrie A.-G. at Ludwigshafen at a production rate of approximately 100 tons per month. The resin is made by the reaction of 1 mol of phenol, 1.2 mol formaldehyde and 0.005 mol potassium carbonate. This resin is combined with an alkyd resin called Weichharz AT, made by reacting 100 parts of adipic acid with 112 parts of trimethylol propane. The compositions of a representative group of such phenolic lacquers are as follows:

*9—Home of Eckert & Ziegler in Koln, specialists in injection machines. This firm moved to Bavaria before the Allies commenced their intensive bombing attacks*

| *Luphen type* | *Phenolic resin* | *Alkyd resin* | *Ethyl cellulose* | *Butyl alcohol* |
|---|---|---|---|---|
| | *percent* | *percent* | *percent* | *percent* |
| AW | 24 | 36 | 0.1 | 39.9 |
| AT | 30 | 30 | 0.1 | 39.9 |
| AM | 42 | 18 | 0.1 | 39.9 |

A similar series is made with a resin prepared from technical xylenol, chiefly 1:3:4 and 1:2:4 xylenols and para-cresol; the lacquers are designated as SW, ST and SM, respectively. They are used for baked coatings on metal products, such as steel cartridge cases and milk cans.

Another series of lacquers (BW, BT and BM) is made with a resin prepared from *p*-tertiary-butyl phenol. The B type Luphens are used primarily for electrical purposes, such as wire coating because of their good elasticity.

The I. G. plant at Hochst produces phenolic resin cements, known by the name Asplit, for jointing tiles and bricks and lining tanks. They are used where resistance to acids, alkalies and solvents is required. Two types of Asplit resins are produced according to the following formulas:

| *Ingredient* | *Asplit S* | *Asplit AN* |
|---|---|---|
| Phenol | 825 | 550 |
| Formaldehyde (30 percent) | 1020 | 1020 |
| Sodium hydroxide (45 percent) | 160 | 160 |

The cements are prepared by mixing these resins (70 percent solids) with a mineral filler and a hardening agent. The preferred filler is Kieselweiss, which is a very fine powder, intermediate between quartz and clay. It is found in the upper Danube area. When Kieselweiss was unavailable, a mixture of fine quartz and china clay was used. The acid hardener is technical *p*-toluenesulfonyl chloride. The technical grade is used because it contains a proportion of the *o*-isomer which is more acidic than the *p*-isomer and thus accelerates hardening. β-Naphtholsulfonyl chloride has also been used. This is slower in action than *p*-toluenesulfonyl chloride and is never used alone. It is mixed with *p*-toluenesulfonyl chloride, the maximum ratio being 4 parts β-naphtholsulfonyl chloride and 6 parts *p*-toluenesulfonyl chloride. In cold weather Asplit is slow hardening with *p*-toluenesulfonyl chloride. In this case 1 percent of a mixture of benzene and sulfuric acid in the proportions required for mono-sulfonation of benzene is added.

The compositions of the different grades of Asplit products are as follows:

*Asplit S*—Resistant to all acids except oxidizing acids;

resistant to sodium carbonate; used for jointing tiles and bricks.

| *Powder* | *Liquid* |
|---|---|
| 10 percent *p*-Toluenesulfonyl chloride | 100 percent Asplit S (90 percent phenol-formaldehyde condensation product, 10 percent benzyl alcohol) |
| 20 percent Silica | |
| 70 percent Quartz powder | |

*Asplit A*—Resistant to all acids except oxidizing acids and to caustic soda; used for jointing tiles and bricks.

| *Powder* | *Liquid* |
|---|---|
| 10 percent *p*-Toluenesulfonyl chloride | 100 percent Asplit AN (75 percent phenol-formaldehyde condensation product, 5 percent benzyl alcohol, 20 percent dichlorohydrin) |
| 70 percent Barium sulfate | |
| 20 percent Quartz powder | |

*Asplit EI*—Resistant to all acids except oxidizing acids and to caustic soda and organic solvents; used for coating large concrete tanks, particularly for petrol at submarine supply dumps.

| *Powder* | *Liquid* |
|---|---|
| 6.5 percent *p*-Toluenesulfonyl chloride | 100 percent Asplit AN |
| 1.5 percent Povimal C | |
| 1.0 percent Kieselguhr | |
| 10.0 percent Silica | |
| 41.0 percent Quartz sand | |
| 40.0 percent Quartz powder | |

Povimal C is a copolymer of vinyl chloride and maleic anhydride. It is used to give a certain degree of elasticity to the Asplit coating which otherwise tends to be brittle.

Powder and liquid are supplied separately and mixed by the user. All types of Asplit cements require 2 to 3 hr. at 20° C. for hardening. E1-Asplit is hardened by hot air. The material is applied to the concrete by trowel and the hardening is accelerated by a current of hot air from a portable stove and blower. The total output of Asplit liquid is 60 to 70 tons per month.

A new type of phenolic resin, called Koresin, was produced during the war in Germany by the reaction of acetylene (6 mols) and *p*-tertiary-butyl phenol (5 mols) in the presence of zinc naphthenate. This resin is used as a tackifier for synthetic rubber. The output was 40 to 50 tons per month.

Phenolic laminates were produced by Dynamit A.-G., Troisdorf (Trolitax), Dielektra A.-G., Porz (Pertinax), and by various firms in the Berlin area. During the war the papers and fabrics used were made from wood pulp. The principal grades were as follows:

Paper (soda pulp): 40,60,70,350 gm./m.²
Fabric (wood fiber): 150,225,575 gm./m.²

The impregnating resin is made with 1500 kg. cresol, 1350 kg. formaldehyde (30 percent) and 75 kg. ammonia (25 percent), condensed for 2 hr. at 80 to 90° C. and subjected to vacuum distillation to remove water. The resin content of the laminates is varied from 30 to 50 percent. The sheets are pressed and cured at 160 to 165° C. and 90 to 120 kg./cm.² pressure. The applications of laminates in the electrical, transportation, communication and construction industries parallel similar practice in the United States. Production at Troisdorf was approximately 100 tons per month; at Porz, 180 tons per month.

Laminated wood is made by Dynamit A.-G. under the trade name Lignofol. Production was about 170 tons per month, half of which was made with Tego film and half with an alcohol-soluble cresol resin. The Tego film is used for Lignofol made with third quality (irregular grain) veneers which cannot be handled wet without splitting. The resin content is limited to about 3 to 4 percent. The compression of the wood is approximately 50 percent. Lignofol for aircraft propeller blades is required to have a tensile strength of not less than 2400 kg./cm.² and a moisture content of 6 to 9 percent; upon boiling in water for 1 hr. the moisture absorption must not exceed 5 percent. The impact strength was stated to be 45 to 50 kg./cm. Other uses for Lignofol are aircraft dies, bearing plates, gears, casters and textile machinery accessories.

A laminated wood, Durofol, made by impregnating beech veneers of 0.2 to 0.3 mm. thickness with 25 to 35 percent of a water-soluble phenolic resin is produced by Ritter, Esslingen/Wurttemberg. Its density is the same as Lignofol, but its impact strength is only about one-tenth as much. It was used for making canteens and bayonet scabbards.

An interesting development in the phenolic field is the substitute for sleeve bearings, known as Schaeferfolie. Finely woven hemp, 40 to 60 gm./m.², is impregnated on one side with phenolic resin. The inside surface of the steel roller is roughened and the hemp fabric is held against it by a snugly fitting aluminum rod. When the assembly is heated to cure the resin, the greater expansion of the aluminum rod provides the necessary pressure to bind the hemp to the steel. These impregnated-hemp bearing surfaces are said to have been used successfully on aircraft.

Another similar product is a resinous lining for steel developed by Bisterfeld and Stolting, Radevormwald, to take the place of bronze and brass in aircraft parts. The resin is made from 100 parts phenol, 76 parts formaldehyde (37 percent) and 2.6 parts of sulfuric acid, condensed at 110° C. for 2½ hours. The volatile content is reduced to 5 percent by distillation to yield a resin of 85 to 90° C. melting point. This is ground on rolls to make a mixture consisting of 48 parts resin, 1.6 parts hexamethylenetetramine, 46 parts precipitated chalk, 6 parts glass fiber and 0.9 part stearin. This is injected into the steel tubing or threaded joint and cured at 180° C. for 1½ minutes. The resin-lined steel is used for aircraft parts, such as couplings for raising and lowering elevators and ailerons, and is said to be much superior to bronze in strength and friction properties.

The firm of Bisterfeld and Stolting also uses a novel method for evaluating the degree of cure of phenolic moldings. It employs the Schmidt-Bisterfeld hot-needle indentation machine developed in 1937 to replace the Vicat needle test which requires heating the molded part in an oven and is time consuming (approximately 2 hr.). The new apparatus has a VDR steel needle which is heated to the desired temperature (200°, 250° or 280° C.). This is applied to the cooled molded part under a load of 40 kg. and the indentation occurring in 60 sec. is measured. It has been found that an indentation of 1.2 to 1.4 mm. in 60 sec. is indicative of the proper cure for most phenolic resins. The test does not destroy the molded part and only requires 2 to 3 min. to make. It has enabled the firm to determine quickly the proper curing conditions for each batch of molding powder and hence to reduce greatly the number of rejects.

## Urea resins

Urea resins for molding compounds (Pollopas) are made by Dynamit A.-G., Troisdorf, for lacquers (Plastopal) by I. G. Farbenindustrie A.-G. at Ludwigshafen and Oppau, and for glues (Kaurit) by the I. G. plants at Oppau and Uerdingen. Production of urea molding materials was 200 to 270 tons

per month pre-war and about 60 tons per month during the war. Production of Plastopal resins was about 150 tons per month and of Kaurit about 330 tons per month.

Three grades of Pollopas molding powder are made of the following compositions:

| *Ingredient* | *Pollopas normal* | *Pollopas universal* | *Pollopas special* |
|---|---|---|---|
| | *kg.* | *kg.* | *kg.* |
| Urea | 90 | 120 | 110 |
| Thiourea | 40 | ... | 20 |
| Formaldehyde (30 percent) | 300 | 300 | 300 |
| Cellulose (85–88 percent alpha) | 105 | 105 | 105 |
| Ammonia (0.90 sp. gr.) | 4.5 | 5.4 | 4.5 |
| Magnesium carbonate | 0.13 | ... | 0.13 |
| Zinc stearate | 0.95 | 0.5 | 0.9 |
| Hexamethylenetetramine | .. | 1.5 | .. |
| Zinc oxide | .. | 0.1 | .. |

The pH of the mixtures is maintained at 7.0 during condensation, grinding and ball milling, otherwise the material is unstable. The pH tests are made colorimetrically, using conductivity water. $\alpha,\alpha$-Dichlorohydrin (0.8 percent) neutralized to brom thymol blue with $N/2$ sodium hydroxide is added to Pollopas Universal as a hardening agent unless the material is intended for use with hot liquids; in the latter case zinc sulfate (1.5 percent) is used. This is more difficult to disperse and does not cure as rapidly as dichlorohydrin. Pollopas Special is made with technical grade urea and is only used for pigmented compounds. Black urea materials are not made because the compounds are only stable for 10 to 12 weeks in the presence of the aniline black dyes. A wood-filled (50/50) urea molding compound was made during the war but is only stable for 8 to 10 weeks. No important war uses had been found for urea molding materials.

Two main types of urea lacquer resins are made at Ludwigshafen, Plastopal AT and AW. These are mixed in solution with a soft alkyd resin made from 100 parts adipic acid and 112 parts trimethylol propane. The urea condensation product is made by heating a charge of 1850 kg. formaldehyde (40 percent), 640 kg. urea and 90 kg. ammonia (25 percent) for 1 hr. at 95° C. Then to make Plastopal AT 775 kg. of the soft resin (72 percent in butyl alcohol) is added and the water removed by distillation. More butyl alcohol is added to produce a solution containing 50 percent solids. It is thought that a reaction takes place between the dimethylol urea and the alkyd resin. Plastopal AW is made by mixing 1780 kg. Plastopal AT, 3320 kg. soft resin and 1460 kg. butyl alcohol to yield 8000 kg. of a solution with 50 percent solids.

The Plastopals are used as baking and air-drying lacquers for coating tin cans, wires, railway cars, industrial machinery, and the like. The baking temperature recommended is 180° C. For cold-hardening 10 percent of alcoholic hydrochloric acid solution (5 percent) is added to the lacquer. Plastopal AW gives more flexible films than Plastopal AT.

Special urea resins for use in protective coatings are also made by the I. G. plant at Oppau. Plastopal CB is based on a resin consisting of 89 percent dimethylol urea condensed with 11 percent of an alkyd made with phthalic and maleic acids and 1,3-butylene glycol. Plastopal ATX is made according to the following formulation:

| | |
|---|---|
| Urea | 14.1 kg. |
| Formaldehyde (30 percent) | 54.2 kg. |
| Butyl alcohol | 22.5 kg. |
| Toluene | 0.7 kg. |
| Hexanetriol | 26.6 kg. |
| Adipic acid | 23.3 kg. |
| Propyl alcohol | 21.1 kg. |

It can be baked at 120° C. to a high gloss finish. In admixture with phenolic resins it gives enamels of high insulating value, oil resistance and toughness. It is particularly good on machinery where wires are rubbing against one another.

Kaurit W, the urea-formaldehyde resinous base of the Kaurit glues, is made at Oppau. One mol of urea (technical) and 2 mols of formaldehyde (30 percent solution) are reacted together to form a 36 percent resin solution. This is concentrated by heating (65° C.) in vacuo. Then 8 to 10 percent of wood, rye or potato flour is added to yield a mixture composed of 55 percent resin, 10 percent flour and 35 percent water. This is neutralized to pH 7.0 with sodium hydroxide and is designated Kaurit W-Liquid. To make Kaurit W-Powder it is spray dried to 2–3.5 percent moisture content. In 1937 a Kauritfilm W was made but proved to be too unstable for commercial use.

Kaurit WHK-Powder is a cold assembly glue. Its composition is as follows:

| | |
|---|---|
| Kaurit W-Powder | 75.7 parts |
| Trolitan-Pressabfalle | 21.65 parts |
| Paraformaldehyde | 2.65 parts |

The bulk density of this powder is about 65 g./100 cc. The Trolitan-Pressabfalle is a phenolic powder prepared from rejected moldings or flash at Troisdorf which is ground and passed through a 0.3-mm. sieve.

For hot-press work a solution of ammonium chloride (8 parts), ammonia (27 parts of 25 percent conc.) and urea (45) is employed as the hardening agent. Ten parts of this hardener are used with 100 parts of Kaurit W-Liquid. When maximum water resistance is required, 10 to 25 parts of a mixture of resorcinol (90) and ammonium chloride (10) were mixed with 100 parts of Kaurit W-Liquid.

For cold gluing one side of the veneers to be bonded is coated with a solution consisting of ammonium chloride (15), water (78) and ethyl alcohol (6). After drying at room temperature, the other side of the veneers is coated with Kaurit W and they are then pressed together immediately. The hardening time is 3 hr. at 20° C., 10 hr. at 15° C., or 24 hr. at 10° C. No hardening occurs below 6° C.

A special foamed glue made from a mixture of casein,

**10**—*Alkyd resin unit at Uerdingen. This plant was also the center of I.G. work on various adhesives*

Kaurit W-Liquid, woodflour, potato starch and hardening agent is also employed to get an economical spread in the manufacture of plywood. The foam has 2.5 to 3 times the volume of the liquid. Although casein was very scarce in Germany during the war, it was allocated for this application.

### Melamine resin

Dynamit A.-G. manufactures a melamine molding compound known as Ultrapas. It is made with 1 mol of melamine and 1 mol of urea. A typical batch composition is as follows:

| | |
|---|---|
| Melamine | 126 kg. |
| Urea | 60 kg. |
| Formaldehyde (30 parts) | 300 kg. |
| Ammonia (0.90 sp. gr.) | 5 kg. |
| Charcoal (Norit) | 1 kg. |

This is condensed at 80° C. for 20 min. at a pH of 6.8. The solution is filtered and adjusted to pH 7.0 with dilute sodium hydroxide. It is then mixed with 160 kg. cellulose, 1.2 kg. zinc stearate and 0.25 kg. magnesium carbonate. The latter is added as a stabilizer to prevent the pH from falling below 7.0. This melamine-urea mixture has water resistance and mechanical strength nearly equal to that of the more costly straight melamine product.

The costs of raw materials and manufacturing costs of the molding compounds of the urea and melamine types were as follows:

| | *mk./kg* |
|---|---|
| Urea, technical | 0.42 |
| Urea, pure | 0.60 |
| Thiourea | 1.41 |
| Melamine, technical | 1.90 |
| Melamine, pure | 2.42 |
| Pollopas Normal | 1.11 |
| Pollopas Universal | 0.995 |
| Pollopas Special | 0.937 |
| Ultrapas | 1.43 |

Production of Ultrapas was approximately 50 tons per month.

A melamine resin for lacquer purposes is made by the I. G. plant at Mainkur. The preparation of this resin and the lacquers paralleled the practices employed in making Plastopal AT and AW. Known as Maprenal, these lacquers have better water resistance but are not as easily plasticized as the urea materials.

### Cellulose plastics

Cellulose acetate plastics are made in Germany by Dynamit A.-G., Troisdorf, from cellulose acetate supplies by the I. G. plant at Dormagen. The trade names are Trolit for the molding powder and Cellon for the sheeting. Cellulose acetate flake of 51 to 52.5 percent acetic acid content is used for both products.

To make the molding powder the cellulose acetate is mixed cold with 23 to 35 percent of dimethyl phthalate and some water (because of unavailability of alcohol for this use during the war). The mix is transferred to hot milling rolls to homogenize the materials and the mass is cut into granules for molding. Production has been limited to about 25 tons per month for electrical insulation, telephone parts and for combs.

The Cellon sheeting is made by the standard block process. Approximately 30 percent plasticizer is used, consisting of various mixtures of the following compounds: Triphenyl phosphate, dimethyl phthalate, *p*-toluenesulfonic acid diethylamide, and trichloroethyl phosphate. Production has been about 150 tons per month for gas mask lenses, windows for automobiles, airplanes, and tents, propeller covers and safety glass.

Ethyl cellulose is made by the I. G. plant at Elberfeld, using beech wood pulp (98 percent alpha cellulose) made at Wolfen by the nitric acid process. The raw materials required per batch (56 kg.) are 45 kg. cellulose, 628 kg. caustic soda (50 percent solution), and 220 kg. ethyl chloride. The ethoxyl content of the ethyl cellulose is 47 to 48 percent. Viscosity is controlled by the amount of air admitted into the reactor; the more air added, the lower the viscosity. Viscosity is determined by the time required for an air bubble to travel from bottom to top of a 5 percent solution of the ethyl cellulose in 9 parts benzene and 1 part ethyl alcohol contained in a tube of 50 cm. height. The following grades are made:

| | |
|---|---|
| Very low | 10 sec. |
| Low | 14 sec. |
| Medium | 20 sec. |
| High | 30 sec. |

Ethyl cellulose has not been used commercially in Germany for the manufacture of plastics. Its principal use has been in lacquers, particularly for cable insulation. Production has been approximately 7 tons per month, selling for 6 to 7 mk./kg. Ethyl chloride was supplied by Ludwigshafen at 0.8 mk./kg.

Benzyl cellulose is prepared in the same type of reactors as ethyl cellulose, using 330 kg. benzyl chloride, 360 kg. caustic soda (50 percent solution) and 79 kg. cellulose to make 130 kg. of the derivative. The benzyl content is 51 percent (2.0 to 2.2 substitution) and the viscosity (5 percent solution in benzyl alcohol) grades are 10, 12, 16 and 22 seconds. Its use has been largely for insulation lacquers and aircraft dopes. Small quantities have been used experimentally for molding battery cases. Production has been 10 to 15 tons per month, selling for 3 to 4 mk./kg. Benzyl chloride was supplied by Uerdingen at 0.65 mk./kg.

Carboxymethyl cellulose is made by the I. G. plant at Elberfeld and by Kalle and Co. at Wiesbaden-Biebrich. A batch at Elberfeld requires 130 kg. cellulose, 272 kg. caustic soda (50 percent) and 162 kg. monochloracetic acid. Known as Cellaprit, carboxymethyl cellulose is supplied as a paste in admixture with water to the textile and printing trades for use in sizings, adhesives, thickeners, stiffening agents and color printing. Production of this derivative at Elberfeld was approximately 20 tons per month, selling for 2 to 3 mk./kg. Production of this derivative and methyl cellulose by Kalle was approximately 160 tons per month.

Very little cellulose nitrate was used in the production of plastics in Germany during the war. Pyroxylin glues were made at Uerdingen at the rate of approximately 130 tons per month. They are used for household and general purpose gluing. The principal producer of cellulose glues other than the pyroxylin type is Kalle and Co., which manufactured methyl cellulose adhesives (Glutolin and Glutofex) and carboxymethyl cellulose (Cellaprit). Another source of cellulose derivatives is the I. G. plant at Dormagen which made the acetate, triacetate, tripropionate and acetate butyrate. Kalle and Co. are the principal producers of cellophane, including a moistureproof type made by the incorporation of a rubber solution directly into the viscose solution. This is done prior to the preparation of the regenerated cellulose film.

# TECHNICAL SECTION

DR. GORDON M. KLINE, Technical Editor

# Survey of Adhesives and Adhesion*

## Part I. Theoretical Aspects of Adhesion

by R. C. RINKER and G. M. KLINE†

*This review of the fundamentals of atomic forces as related to adhesion is particularly timely in view of current disclosures regarding the use of atomic energy in bombs. One writer in advancing a popular explanation of atom splitting remarked that the particles making up an atom were "held together by glue—good glue, too." This article discusses the forces that are involved in the adhesion and cohesion of materials. Part II in the November issue will describe methods of measuring adhesive strengths.*

ALL matter is composed of discrete particles or atoms which are held together by electrical forces of attraction.[1,2] These forces operate between the positively charged atomic nuclei and the negatively charged orbital electrons. By studying the physical and chemical properties of compounds of atoms it has been possible to recognize certain types of these attractions as differing from others. These differences, however, are not distinct and only in extreme cases is a bond a manifestation of a pure type. It is much closer to the truth to think of these bonds as having well-defined properties, but to bear in mind that the transition from one type to another is not sharp and may be very gradual. When a bond is formed, it does not mean that all of the forces between the electrons and nuclei of the two participating atoms have been neutralized. Rather, it signifies that a force concentration has been set up in a certain direction. Residual energy is always present.

In explaining chemical and physical phenomena it is convenient to recognize four general types of bonds: electrostatic, covalent, metallic and residual bonding attraction forces, commonly known as van der Waals forces.

### Electrostatic or polar bonds

Kossel[3] in 1916 showed that an element immediately preceding a rare gas in the periodic table is strongly electronegative, whereas one immediately following it is strongly electropositive. The rare gases, on the other hand, are remarkably inert. He concluded that this behavior was due to a tendency on the part of the reactive elements to change their configurations in order to conform with those of the rare gases. Thus, an atom of potassium combines with one of chlorine by means of an electron transfer which results in the configuration of argon for each.

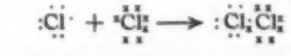
By means of this mutual claim on the shared electron the two ions will remain closely associated with one another as potassium chloride. This association can be interfered with, however, as by solution in water, in which case the potassium chloride will dissociate into chlorine as a negative ion, and potassium as a positive ion. If the water is removed by evaporation, these ions will align themselves to form a crystal lattice. In such a solid the attractive forces between the oppositely charge ions, except those on the surface, will be satisfied. However, in an amorphous solid some of the attractive forces will not be satisfied because of randomness of distribution of the ions.

### Covalent Bonds

Compounds which are formed of atoms removed by three places from the rare gases in the periodic table show a greatly lowered tendency to ionize. Thus, ammonia and phosphine are only very slightly ionized. In many molecules it is difficult or impossible to determine which atom is positive and which negative, e.g., sulfur dioxide and carbon dioxide and, still more strikingly, the diatomic gases such as hydrogen and chlorine. These substances do not ionize in solution.

In 1916, G. N. Lewis[4] proposed that in substances of this type it is possible for two atoms to share electrons in such a way as to account for the stability of each in attaining the rare gas configuration. Langmuir suggested that this type of linkage be termed "covalent".

*True covalent bonds*—In a diatomic molecule such as chlorine gas, each atom requires an electron to complete its outer shell. In each atom the positive attraction of the nucleus is equally great on each of the two negative charges of the shared pair. This may be represented as follows:

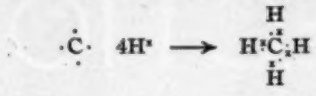


Such bonding is the most common form in organic molecules and accounts for their complexities and magnitudes. Thus, carbon has an outer shell of four electrons which it will share with as many atoms as will contribute toward a stable structure of eight.

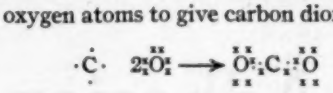
(*Please turn to next page*)

* National Advisory Committee for Aeronautics, Technical Note No. 989.
† National Bureau of Standards.

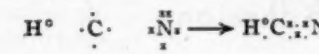
1. Monovalent atoms. Carbon may share an electron with each of 4 hydrogen atoms to give the stable gas methane:



2. Divalent atoms. Carbon may share two electrons with each of two oxygen atoms to give carbon dioxide:



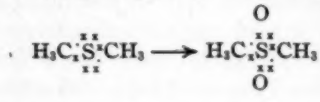
3. Trivalent atoms. Carbon may share 3 electrons with one nitrogen atom in a covalent bond, as in hydrogen cyanide:



Carbon also has the ability to form covalent bonds with itself an almost infinite number of times. It is well established that the structure of crystalline carbon (diamond) is formed by single covalent bonds, accounting for its great stability.

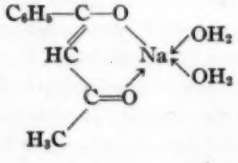
*Coordinate covalent bonds*—Compounds exist, the properties of which do not fit into any of the previously discussed categories. In 1892 Werner[5] advanced a theory to account for them. These substances, formerly shelved under the name "molecular compounds," appear to result from the union of two or more saturated molecules. They are also apparently independent of the groups in the periodic table to which the atoms involved belong.

Because of its position in the periodic table, sulfur can form only the two normal covalent bonds because this brings about the completion of its full complement of eight electrons. Of these eight, two are shared with other atoms, as in dimethyl sulfide. This compound can, however, be oxidized as follows:



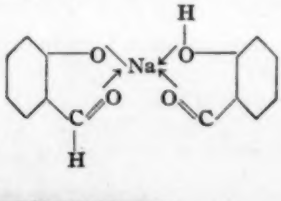
The two oxygen atoms have received two electrons each from the sulfur; thus their outer valence shells are complete, whereas the sulfur already had a saturated shell.

This same mechanism is used to explain another phenomenon occurring in organic molecules; namely, the chelate compounds. The peculiar properties of the hydrate of the sodium derivative of benzoyl acetone indicate that this substance may be represented by the following formula in which the arrow indicates that two electrons are contributed by each such oxygen atom.

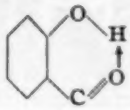


If this water were present as water of crystallization, the compound should have the same chemical properties as the anhydrous salt. The hydrate, however, dissolves in toluene whereas the anhydrous salt is insoluble.

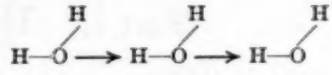
A similar example is given by the behavior of ortho substituted phenols such as salicylaldehyde which form chelation compounds readily.



Further evidence indicates that the phenolic hydrogen in salicylaldehyde is itself linked to the oxygen of the aldehyde group in this same manner:



This leads to a very important case of this type of bonding: namely, the formation of hydrogen bridges between molecules. Many substances containing hydroxyl groups exhibit this phenomenon and even water has been shown to have a trimeric structure in ice.

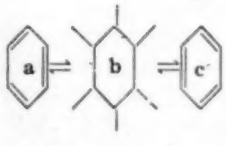


The fact that most molecularly associated substances contain hydroxyl or related groups leads to the conclusion that this type of bond may play a very important role in cohesive or adhesive phenomena.

## Metallic Bonds

The metals which comprise the greatest number of elements in the periodic table, owe their unique properties to a bond type which was not recognized until recently. Lorentz[6] first advanced the theory that a pure metal consists of a crystalline arrangement of metallic cations with free electrons moving in the interstices. In 1927, Pauli[7] postulated that these electrons exist in a continuous set of energy levels. At absolute zero they occupy the most stable levels in pairs with oppositely opposed spins so that they would be unavailable for orientation in an applied magnetic field. As the temperature rises, however, these stable pairs would be broken down as one electron rises to a higher energy level with the result that the paramagnetic susceptibility of the mass would be raised until finally a point is reached at which paramagnetic susceptibility is independent of temperature.

If a simple metal such as the lithium crystal is considered, an arrangement of eight atoms is found at the corners of a cube. The distances of these atoms from one another satisfy the crystallographers' requirement for a single electronic bond. Other characteristics indicate the existence of double electron bonds as well. The stability of the structure may be explained on the basis of the theory of resonance which has been applied to many types of structures in organic chemistry. It is the same concept which explains the familiar Kekulé structure of the benzene molecule in which the double bonds are visualized




as alternating between the configurations (a) and (c) with (b) as an intermediate.

Thus any two atoms in a lithium crystal may be linked by two electrons or by one electron at a given instant. The single electron bonds are also used to account for the halides of boron having structures which could be explained in no other way. In effect the resonance between single and double electron bonds is a very specialized case of covalent bonds.

## Van der Waals forces

Up to this point the more potent forces of attraction between atomic nuclei and orbital electrons have been discussed. All of these interactions may be thought of in

terms of units of energy. These units, however, participate in maximum and not total exchanges. When a bond is formed the positive and negative charges of the participating molecules are not completely neutralized. There remain in many molecules residual energies which are very nearly of stable bond forming magnitudes. These forces affect the melting and boiling points of many substances.

Matter composed of both electrons and protons always exerts attraction. A liquid will wet a solid surface to a degree dependent upon the magnitudes of the attractive or adhesive forces between the two substances and the cohesive forces within each. In the case of a drop of mercury on a glass surface the cohesive force within these two materials is much greater than the adhesion between them, consequently the mercury droplet almost forms a sphere, but there is sufficient attraction to distort this shape.

Many substances which will react at higher temperatures are attracted by van der Waals forces at lower ones. It will be seen later that these attractive forces initiate reactions by virtue of the fact that their magnitudes are potent over greater distances than those of an electrostatic nature which are responsible for bond formation.

It was in recognition of these facts that van der Waals presented his corrected version of the equation of state for gases and means for calculating the magnitudes of these residual attractive forces for all substances. It has been found that they are greater for the molecules of compounds than for molecules of elements or inert atoms, thus showing that unequal distribution accounts for a greater residual force field and, consequently, the more asymmetric the molecule the greater these values will be. This is a matter of great importance in explaining adhesive and cohesive properties.

## The Nature of Cohesion

The mechanism whereby molecules or atoms in homogeneous matter are held together is known as cohesion. The physical state as well as the mechanical properties of the material depend upon the type and magnitude of its cohesive bonds. The operational effects of such bonds have been investigated by Lennard-Jones and coworkers[8] by considering the case of an external particle approaching a crystalline surface. In such instances one of several phenomena may occur.

*Chemical attraction*—If the particle is an ion, a direct electrostatic force will be set up between the charges on the approaching ion and the ions on the surface of the crystal.

*Polarization*—Whether the particle is charged or not, an induced dipole will be set up in the atom or ion by the electric field of the crystal. If the particle is charged, it will polarize the ions in the crystal.

*Attraction through van der Waals forces*—Inasmuch as attraction exists even between two so-called neutral atoms (atoms of a rare gas), it is assumed that a similar attraction will be exerted between the crystal ions and the charged or uncharged particle, quite apart from the effect of their valency charges.

On the basis of this analysis, these investigators calculated these effects between neon and a charged particle, respectively, near the 100 plane (planes parallel to the face) of a sodium fluoride crystal; and between argon and a charged particle, respectively, near a potassium chloride crystal. These calculations showed that the electrostatic attractions fall off very rapidly as the distance from the surface increases, but are very powerful within a short optimum range. The van der Waals attractions, on the other hand, have a much wider range, but are never so powerful as the electrostatic attraction. The polarization forces never become very great. These relationships are illustrated in Fig. 1.

These forces, with different degrees of magnitude, are responsible for the cohesion between ions, atoms and molecules of all forms of matter. On the basis of this evidence as well as the fundamental precepts of chemistry and physics, it is possible to ascribe points of strength and weakness to these forces in their cohesive capacity. The net effects of these forces determine the gross mechanical properties of all materials.

It must be realized, however, that the intrinsic strength which is indicated for materials is rarely achieved. When a test specimen of crystalline rock salt is broken in tension, the breaking load is 0.4 kilogram per square millimeter, whereas the calculated tensile strength is 200 kilograms per square millimeter. Joffé[9] found, however, that by surrounding the test specimen with hot water, loads as high as 160 kilograms per square millimeter could be obtained. He explained this on the ground that "premature" failure is due to the presence of submicroscopic scratches or fissures on the surface of the specimen, around which extremely high stresses may be concentrated. By removing these fissures as they were formed, i.e., by continually dissolving away the surface, he was able to break the bonds along a plane of the crystal and thus approached the theoretical strength.

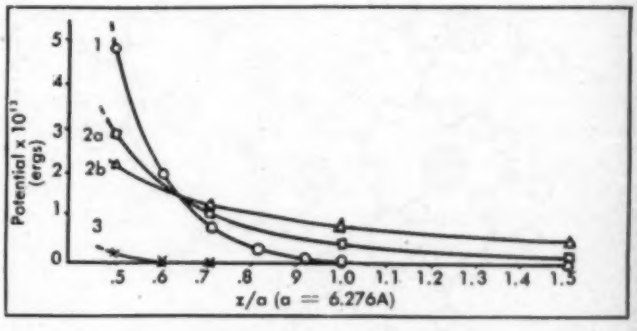
The presence of these minute cracks has been proved[10] by sputtering metallic films on crystalline surfaces which results in fine lines of the metal. The reason for these cracks probably lies in the fact that ideal packing in crystals does not exist due to greater electrostatic forces within the substance than near the surface, thus strains are set up which cause the surface atoms to rearrange with relative ease under an applied load.

A brief consideration of several types of materials will serve to illustrate the behavior of the different cohesive forces.

### Crystalline matter

The criterion of crystallinity is the regularity of the arrangement of the atoms in a solid structure.[11] Any atom in a crystal is separated from its neighbors by the same distances and at the same angles as any other atom of the same kind.

When a true crystal is subjected to a tensile stress it will



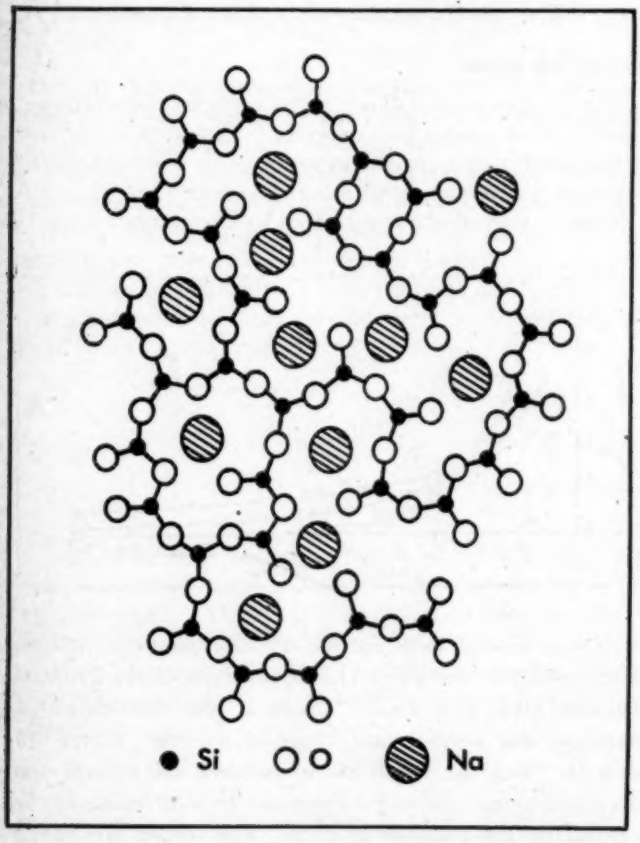

***1—The potential field outside a (100) plane of KCl on a charged particle (curve 1) and on argon (curve 2) (from Lennard-Jones and Dent). Curve 1: Electrostatic force between the crystal and charged particle. Curve 2a and 2b: Van der Waals forces between the crystal and an argon atom. Curve 3: Force due to polarization of the crystal by the charged particle. The forces are calculated from a particle at a distance "3" from the crystal surface in which the ions are separated by distance "a"***

rupture along the line of least resistance. The structure of crystals has been well established by x-ray and chemical studies. Hence it is possible to identify the forces which were overcome along the cleavage plane.

*Covalent crystals*—In the crystals of non-metallic elements, single atoms share electrons with each other in pairs. Since neither atom exerts a greater influence on the bond than the other a state of relative inertia exists. Two factors determine the effect of these bonds in providing cohesive stability, the bond distances, and the bond angles. The first of these factors determines the range over which the attractive force acts and how much it is interfered with by electrons closer to the nucleus of each atom. The second determines the configuration of the crystal.

It has been shown that carbon is capable of forming single, double and even triple covalent bonds. That bond angle influences the structure is shown by the properties of diamond and graphite, whereas the effect of bond distance is illustrated by comparing diamond and crystalline silicon.

Diamond is the hardest and most inert of all crystals. It consists of carbon atoms joined to one another by primary covalent bonds, thus at the end of each carbon tetrahedron there is another carbon atom. There is relatively little strain in such a crystal and the distances between each atom and the next are relatively small. In the case of graphite, on the other hand, each carbon atom is attached to three of its neighbors instead of four, two through single bonds and one through a double bond. The angle of the double bond is quite different from that of the single. The result of this arrangement is the formation of layers of two-dimensional plates which are rather loosely held by van der Waals forces in the crystal. That these van der Waals forces are strong enough to give some stability to the structure is to be expected from the fact that the energy of the double bond is less than twice that of a single bond.



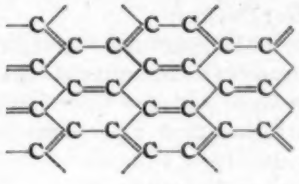

*2—Schematic representation in two dimensions of the structure of soda-silica glass (from Warren).*

In crystalline silicon in which the atoms have the same arrangement as in the diamond crystal, the bond distances are greater and the bond energies are consequently less, thus a weaker structure results.

(Diamond) (Silicon)

Bond distance = 1.54 Å
Bond energy = 58.6 k. cal./mol.

Bond distance = 2.34 Å
Bond energy = 42.5 k. cal./mol.



(Graphite)

| | single bond | double bond |
|---|---|---|
| Bond distance Å | 1.54 | 1.34 |
| Bond energy, k. cal./mol. | 58.6 | 100 |

*Ionic crystals*—Owing to the nature of ionic bond formation by the capture of an electron from an electropositive atom by an electronegative atom, the cohesive strengths of such crystals are weaker than those formed by covalent bonding. An ionic molecule splits into two fractions much more easily under the influence of chemical as well as physical forces. Thus the solubilities are high and the strength properties low as compared to covalent substances. The same rules of bond distance and angles govern these strengths.

*Coordinate covalent crystals*—The coordinate covalent bond has some of the properties of both ionic and covalent bonds. It has been called, in fact, the semipolar bond. The large groups of pure compound minerals are composed of complex crystals in which one molecular type is connected to another by the interlocking of their individual crystal lattices. Pauling[1] has set forth several rules which apply to the types which are more ionic than covalent in character. These rules are based upon the concept that anions are coordinated at the corners of tetrahedral or polyhedral force distributions about each cation and that these polyhedra are joined at a corner, an edge or a face. On this basis the formation and properties of such structures may be predicted as follows:

1. A coordinated polyhedron of anions is formed about each cation, the cation-anion distance being determined by the radius sum and the coordination number of the cation by the radius ratio.

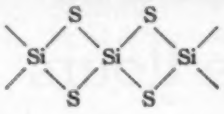
2. In a stable ionic structure, the valence of each anion is exactly or nearly equal to the sum of the strengths of the electrostatic bonds to it from the adjacent cations.

3. The presence of shared edges, and especially of shared faces, in a coordinated structure, decreases its stability. This effect is pronounced for cations with large valence and small coordination number.

4. In a crystal containing different cations, those with large valence and small coordination number tend not to share polyhedron elements with one another.

These rules are so applicable to predominately ionic coordinate bonds that variance from them is a test of predominant covalency. All of the forms of silica obey them which proves the partially ionic nature of the Si O bond, whereas with sul-

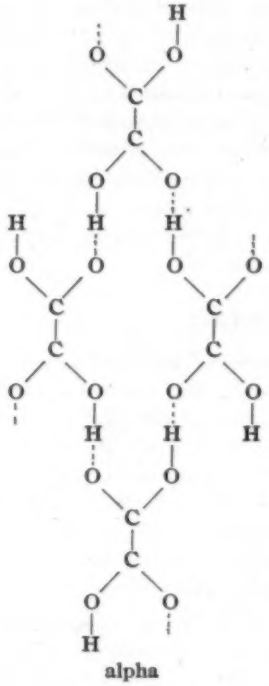
fur, the $SiS_4$ tetrahedra share edges with one another to give infinite chains.



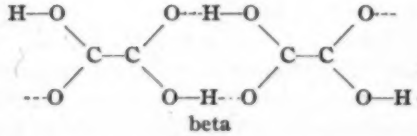
thus proving the Si—S bond to be essentially covalent.

*Crystals containing hydrogen bonds*—The phenomenon of the hydrogen bond is responsible for the unusual properties of water. By analogy with other related compounds such as $H_2Te$, $H_2Se$ and $H_2S$, on the basis of decreasing molecular weights and van der Waals forces, the melting and boiling points of water would be expected to be about −100 and −80° C., respectively.

A good example of C—O—H bonding in crystals is given by the two crystalline forms of oxalic acid. The alpha form of this substance consists of plates and the beta form of long chains.



alpha



beta

The plates and chains are interconnected through very weak van der Waals forces.

*Metal crystals*—The relationship between physical properties and bond distances and angles is the same in metal as in other crystals. If the atomic radii of the metallic elements are plotted against atomic number, it will be seen that a minimum occurs in each case between the sixth and tenth elements of each sequence. In this range, the greatest bond strength occurs and consequently the strongest metallic substances.

As the number of valence electrons per atom increases from 1 to 6, there is a corresponding increase in electron pairs effective in bonding the atoms together in the metal. Between the sixth and the tenth elements the number of electrons remains constant at about 6, but becomes smaller beyond the tenth. These relationships offer an explanation for the fact that properties dependent on cohesive forces, such as yield point and ultimate tensile strength and hardness, reach maxima between the sixth and tenth element in each sequence in the Periodic Table.

*Van der Waals forces*—In crystalline substances the equilibrium of energies in the crystal lattice to give layers and threads (e.g., in graphite and asbestos, respectively) precludes the existence of very great bending forces between these more or less saturated systems. That these forces do vary, however, is evidenced by the much greater interplanar cohesion for graphite than for oxalic acid or mica. These forces, therefore, depend on the crystalline configuration as well as the nature of the individual atoms involved.

## Noncrystalline matter

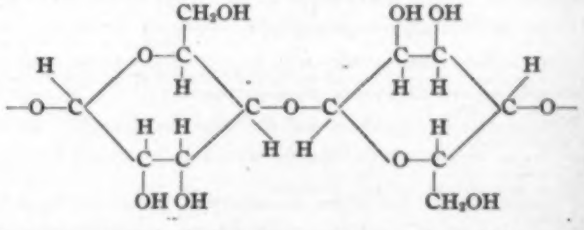
Most materials used for construction are not pure crystalline substances, but do have varying degrees of crystallinity. The cohesive behavior of amorphous substances may be explained on the basis of the more definite knowledge of crystal structure, inasmuch as the same forces hold them together.

*Metals*—Most metals consist of isolated regions of crystallinity surrounded by an amorphous medium. Alloys exhibit the properties of the component parts except where true intermetallic compounds are formed. In the disordered amorphous regions of metals, the cohesion is due to van der Waals forces of high magnitude. This is merely another way of stating that the attractive force does not reach the magnitude of a valence bond. When metals are cold drawn, however, there is a much greater tendency toward crystalline lattice formation with an accompanying increase in cohesive strength.

*Glass*—Silicate glasses are the most common and have been shown by Warren[12] to consist of a random network of silicon and oxygen atoms with each silicon atom tetrahedrally bonded to four oxygen atoms (Fig. 2). All of the oxygen atoms, however, are not bonded to silicon atoms; thus interstices of varying sizes exist throughout the structure. When the composition of the glass is modified by alkali or alkaline earth metals, these interstices become more numerous and each metal ion is surrounded by oxygen atoms with unsatisfied charges and is consequently linked to these through coordinate covalent attractive forces.

Glass structures in general are composed of oxides such as $SiO_2$, $B_2O_3$, $P_2O_5$, $Al_2O_3$, etc., which are known as network formers and oxides of alkali or alkaline earth metals such as $Na_2O$ and CaO which are known as network modifiers.

*Wood*—The structure of wood is, as is true of most complex natural materials, very imperfectly known. Predominantly it consists of long fibers of cellulose joined together by means of lignin. The structure of cellulose is that of a chain composed of glucoside units linked to one another through C—O—C bonds. Neighboring chains are intramolecularly held together by means of hydrogen bonds.



Lignin is not a single substance; its chemical nature varies from species to species.

The bond between cellulose and lignin is in itself a problem of adhesion. Although the greatest strength of wood lies in the direction of the cellulose fiber, (*Please turn to page 196*)

# Agricultural residues in plastics

## Part I. Agricultural residue flours*

by T. F. CLARK[1], R. V. WILLIAMSON[2] and E. C. LATHROP[3]

THE utilization of agricultural residues or farm wastes in the manufacture of plastics has been the subject of inquiries referred with increasing frequency to the Bureau of Agricultural and Industrial Chemistry. Work on this problem at the Bureau's Agricultural Byproducts Laboratory, formerly at Ames, Iowa, was directed to the preparation of thermoplastic lignin molding powders produced by the acid or aniline hydrolysis of such materials as bagasse or cornstalks, followed by compounding with plasticizers such as furfural or aniline.[4-7] One company in Louisiana[8] extended these studies through pilot-plant operations and development work, and is manufacturing thermosetting plastic molding powders from sugar cane bagasse. The thermoplastic compositions produced at Ames required rather long molding cycles, were somewhat deficient in strength properties, and have not proved generally attractive to commercial molders.

The Regional Laboratory program provided for a broad and concentrated attack on the problem of the industrial utilization of agricultural residues at the Northern Laboratory, Peoria, Ill., to which the work at Ames was transferred July 1, 1941. A completely equipped pilot plant for the study of plastics was provided, and the personnel assigned to the plastics problem was increased.

Research was directed first to the use of finely ground residues as a component of thermosetting molding powders. It was recognized that the powders must be capable of use under present commercial molding practices to produce products whose physical properties are at least equivalent to general-purpose powders. If this use were developed, the agricultural residues would require only simple low-cost processing, comparable with the processing of woodflour, and would find a potentially large-volume market, particularly if used with phenol-formaldehyde resins. At the same time, use of the residues in this manner would benefit the plastics industry by making available a greater range of raw materials, many of them of wide geographic distribution. It was also possible that improved molding powders might result from the work. Our entry into the war emphasized the importance of this approach.

For years woodflour has been the standard lignocellulose material which is used with phenol-formaldehyde resins in the production of molding compositions. The present state of perfection of these compositions is the result of extensive research by several large organizations—research work directed toward the perfection of both the woodflour and the phenol-formaldehyde resins in order to produce the best possible physical properties in the final combination of these materials into finished molded articles.

Experiments made in the past to determine the properties of various agricultural residues in phenolic molding compositions led to the general conclusion that agricultural residues were inferior to woodflour in such compositions.[9] The usual experimental procedure was to substitute a ground residue in place of a perfected woodflour in a composition that was known to give good properties. The results with agricultural residues were unfavorable, and no special effort was made to trace or overcome the difficulties.

In this study of the conditions favorable to the use of agricultural residues, it has been shown that agricultural residue compositions can be produced that have molding and physical properties comparable with those made with woodflour. The term "composition" as used in this paper denotes a finished powder ready for molding.

### Experimental procedures

When the experimental work on this project was started, the decision was made to use commercial phenol-formaldehyde resins. Therefore, several different commercial resins, both liquid and powdered, were obtained. Compositions were prepared from these various resins with six different agricultural residues including corncobs, corn stover, wheat straw, flax shives, hemp hurds and peanut shells.

The flours derived from the residues were prepared by grinding the whole residue in a hammer mill using a screen with holes 1/2 in. in diameter, the comminution being completed in a ceramic-lined ball mill (24 by 30 in.). A ball-mill charge consisted of 30 lb. of the residue to 300 lb. of assorted-size porox balls, and a period of approximately 16 hr. or overnight was needed for the grinding of a dry residue. The product, essentially finer than 80 mesh, was air-separated to remove particles of unground fiber and foreign material. Ball-mill grinding produced a granular flour which gave somewhat lower impact values than a more fibrous type of flour, as was shown by a few experiments in which specially ground fibers were used. Ball-mill ground material was used in the major portion of the experiments since practically the entire residue could be conveniently ground to pass a No. 80 U. S. standard sieve. However, it is feasible to grind agricultural residues in the equipment commonly used for producing woodflour and at approximately the same power cost. This has been shown in grinding studies which were conducted with commercial equipment.

The general procedure used in the preparation of the molding compositions consisted in a) mixing or compounding all ingredients in a Banbury mixer at 150° F., b) milling on heated differential rolls to advance the resin and to control the curing time of the product, and c) grinding in a burr mill to pass a

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* Work described in this article was carried on at Northern Regional Research Laboratory, one of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

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[2] In Charge, Plastics and Building Materials Section, Agricultural Residues Division.

[3] Head, Agricultural Residues Division.

[4] S. I. Aronovsky and T. F. Clark, Manufacturers' Record *110*, 22–25, 59 (Mar. 1941).

[5] T. F. Clark and S. I. Aronovsky, "Agricultural Residues, a Comparative Study," MODERN PLASTICS, *22*, 162–4, 198 (Dec. 1944).

[6] T. R. McElhinney and S. I. Aronovsky, "Aniline-Bagasse Plastics," MODERN PLASTICS, *17*, 59–61, 88, 90, 92, 94 (June 1940).

[7] T. R. McElhinney, T. F. Clark and D. F. J. Lynch, "Low-Cost Molding Material from Agricultural Wastes," MODERN PLASTICS *16*, 42–44, 70, 72, 74, 76 (Mar. 1939).

[8] T. R. McElhinney, "Bagasse Molding Compounds," MODERN PLASTICS, *20*, 64–5, 136 (Nov. 1942).

[9] "Fillers for Molding Compounds," Plastics Catalog 1944, Plastics Catalogue Corp., New York, N. Y., p. 286.

No. 35 U. S. standard sieve. . Compounding in a dough mixer may be substituted for mixing in a Banbury, with some modification in the subsequent milling. The conditions of milling varied somewhat with the particular resin, flour or resin-flour combination.

Of the commercial resins used, liquid resins produced strength properties superior to those that were obtained with either one- or two-stage types of powdered resins. The addition of hexamethylenetetramine to the molding compositions showed no improvement. Neither available liquid nor powdered commercial resins imparted to the compositions the water-resistant properties equal to those of commercial molding compositions. Inferior water resistance manifested itself by the tendency of molded specimens to crack when subjected to alternate soaking in water and drying, rather than by the actual amount of water absorbed. Some compositions showed better resistance to cracking than others which absorbed much less water. The method for correction of this defect will be described below.

Standard methods for determining resistance to cracking were too slow and the man-hours required for making the tests were too great to be used for control purposes. For example, compositions ready for molding could be produced within 30 min., but hours or days were required to make the test by standard methods. Therefore, the following rapid control method was developed. Short-skirt 28-mm. bottle caps, molded for periods of 1/2, 1, 2, 2 1/2 and 5 min., were weighed accurately and immersed in individual beakers of boiling distilled water. At the end of 15 min. the caps were removed from the boiling water, immersed 15 sec. in distilled water at room temperature, dried superficially with a blast of air saturated with water vapor, reweighed immediately and allowed to dry at room temperature. (Drying at 105° C. will not accelerate this test as caps which crack at room temperatures will not necessarily crack at the elevated temperature.)

Observations for detection of cracks were made through 2-power binocular spectacles immediately after the test, 24 hr. later and, finally, after 4 weeks. The behavior of a prewar bottle-cap molding composition when subjected to the test was used as the standard of quality. Molded caps of this composition showed no cracking immediately after the test. The cap that was molded for 1/2 min. showed slight cracks after drying for 24 hours. The cap that was molded for 1 min. showed no cracks for several days, but failure occurred some time previous to the end of a drying time of 4 weeks. After the 4-weeks' drying period no cracks had developed in the cap that was molded for 2 minutes.

This method of testing permitted a tentative classification of molding compositions with respect to rate of cure, resistance to water absorption and resistance to cracking within 30 min. from the time that specimens had cooled to room temperature.

## Cause of instability of molded products to water

Using the boiling-water test as a measure of relative resistance to water absorption and cracking, a series of experiments was conducted for the purpose of determining the cause of cracking of molded specimens. Agricultural residues *per se* were eliminated as the cause as a result of comparisons with woodflour compositions, which were no better. Water-soluble materials in the finished molding composition were shown to be primarily responsible for cracking. A molding composition which had been prepared with a liquid resin was extracted with water and air-dried. Specimens molded from the extracted composition satisfactorily met the boiling water test, whereas specimens molded from the original composition had poor resistance.

To determine whether water-soluble components of the residue or of the resin were responsible for poor resistance, molded specimens from compositions of (a) water-extracted flax-shive flour and unextracted dry resin, (b) unextracted flax-shive flour and water-extracted dry resin, and (c) unextracted flax shives and unextracted resin were subjected to the boiling-water test. The extracted flour composition (a) showed decreased resistance to cracking, but improved resistance to water absorption. The extracted resin composition (b) showed improved resistance to both water absorption and to cracking. This indicated that the water-soluble materials in the resin were important factors in connection with resistance both to water absorption and to cracking, evidence which was corroborated by the fact that liquid resin compositions showed poorer resistance than dry-resin compositions to the action of water. However, compositions containing liquid resins produced molded specimens of superior strength properties as compared with those of the available dry resins. Therefore, experiments were directed toward the improvement of the water-resistant properties of liquid resins.

## Extracted resins in compositions of normal resin content

Liquid resins in alcoholic solution could be precipitated readily at room temperature by the addition of excess water, while liquid resins in water solution could be precipitated in the presence of excess water by the application of heat. The advancement of the resins was controlled by the temperature and time of heating, while soluble materials were removed by washing with water. Based on these facts, 20 lb. of precipitated resin were prepared in a dough mixer by adding excess water to a commercial liquid resin in alcoholic solution. The precipitated resin was washed with cold water, dried at 50° C. and ground to a powder in a ball mill. This resin was then compounded with several agricultural residues.

The resistance to water absorption and to cracking of specimens molded from these compositions was uniformly good. Table I shows water absorption values and strength characteristics as determined by A.S.T.M. methods. The formulation of these compositions was as follows: agricultural residue flour, 50 percent; water-precipitated resin, 47.2 percent; black dye, 2.0 percent; zinc stearate, 0.5 percent; calcium oxide, 0.3 percent. Test specimens were molded at a temperature of 320° F. and a pressure of 3000 p.s.i. The

TABLE I.—PROPERTIES OF COMPOSITIONS WITH A PHENOL-FORMALDEHYDE RESIN CONTENT OF 47.2 PERCENT AND A FIBER CONTENT OF 50 PERCENT

| *Composition* | *Flexural strength* | *Tensile strength* | *Impact strength, notched Izod* | *Water absorbed (24 hr. immersion at 70° F.)*[a] |
|---|---|---|---|---|
| | *p.s.i.* | *p.s.i.* | *ft-lb./in. of notch* | *percent* |
| A.S.T.M. specifications for general-purpose woodflour phenolics | 9,500 | 7,000 | 0.24 | 0.80 |
| Corncob | 11,990 | 10,240 | 0.20 | 0.49 |
| Wheat straw | 10,450 | 9,080 | 0.20 | 0.42 |
| Peanut shell | 10,200 | 9,320 | 0.21 | 0.35 |
| Hemp hurd | 9,680 | 7,460 | 0.21 | 0.37 |
| Corn stover | 9,570 | 7,600 | 0.20 | 0.69 |
| Flax shive | 9,530 | 8,730 | 0.20 | 0.36 |
| Woodflour[b] | 11,220 | 8,650 | 0.20 | 0.39 |

[a] Values are for 2-in. diameter disks, 1/8-in. thick, molded for 2 1/2 minutes.
[b] Made from equal parts of knot-free Ponderosa and Lambertiana pines.

molding powder was ground to pass a No. 35 U. S. standard sieve and was preformed previous to molding.

The results in Table I show that with the exception of impact strength, all of the compositions met A.S.T.M. specifications. The compositions made from corncob flour were outstanding in strength properties. Previous tests on corncob compositions using entirely different liquid or dry resins had shown very poor strength properties. This improvement in the strength properties of the corncob compositions showed that the resin must fit the residue in order to obtain the best results. This fact should be borne in mind in connection with the data presented, because proper changes in composition might change the order of merit of the several residues that have been investigated.

That the slightly low impact strength is not a special characteristic of agricultural-residue compositions is shown by the fact that the woodflour composition was also low in impact strength. After these results were obtained, it was found that the low impact strength of these compositions was the result of the granular character of the flours, both corncob and wood, which were produced by ball-mill grinding. By grinding corncobs so that a more fibrous flour was produced, the impact value of the specimens from the corncob compositions met A.S.T.M. specifications for general-purpose woodflour phenolic molding compositions.

Table III gives a comparison of the physical characteristics of compositions from commercial woodflour and from corncobs ground in the following two ways: 1) Granular corncob flour produced in the ball mill and 2) a fibrous flour prepared by milling coarsely ground moist cobs on heated differential rolls. Both the dry resin and woodflour used in these experiments were commercial products which were obtained during the later stages of this research. In all three cases, the same technique of compounding was used. The formulation of each was as follows:

| | *Percent* |
|---|---|
| Lignocellulose material | 50.0 |
| Phenol-formaldehyde resin | 47.5 |
| Black dye | 2.0 |
| Zinc stearate | 0.5 |

Compositions were molded at 350° F. and 3000 p.s.i. pressure from powders ground to pass No. 35 U. S. standard sieve.

The results in Table III show that the composition prepared with fibrous corncob flour was the only one which met fully the A.S.T.M. specifications for general-purpose phenolic molding compositions. Both of the corncob compositions showed flexural and tensile strengths superior to those of the woodflour phenolic. The results in Table III also show that commercial dry resins are available which produce excellent results when combined with agricultural residue flours.

The results shown in Tables I and III indicate that the first objective of this investigation has been successfully accomplished, i.e., that excellent molding compositions can be made by formulating agricultural residues with the normal concentration of phenol-formaldehyde resin (47 percent), if the proper type of resin is used.

## Molding compositions of reduced resin content

In this study, a series of compositions was made from the same agricultural residue flours (*Please turn to page 214*)

TABLE II.—PROPERTIES OF COMPOSITIONS WITH A PHENOLIC RESIN CONTENT OF 35 PERCENT AND A FIBER CONTENT OF 62.25 PERCENT

| *Composition* | *Flexural strength* | *Tensile strength* | *Impact strength, notched Izod* | *Water absorbed (24 hr. Immersion at 70° F.)*[a] |
|---|---|---|---|---|
| | *p.si.* | *p.s.i.* | *ft.-lb./in. of notch* | *percent* |
| A.S.T.M. specifications for general-purpose woodflour phenolics | 9,500 | 7,000 | 0.24 | 0.80 |
| Corncob | 10,000 | 10,210 | 0.24 | 1.03 |
| Wheat straw | 9,390 | 8,710 | 0.21 | 0.95 |
| Hemp hurd | 8,680 | 7,240 | .. | 0.56 |
| Corn stover | 8,350 | 7,890 | 0.20 | 1.68 |
| Flax shive | 8,340 | 7,410 | 0.18 | 0.76 |
| Peanut shell | 8,200 | 6,590 | 0.21 | 0.56 |
| Woodflour[b] | 9,440 | 8,650 | 0.21 | 0.65 |

[a] Values are for 2-in. diameter disks, 1/8 in. thick, molded for 2 1/2 minutes.
[b] Prepared from equal parts of knot-free Ponderosa and Lambertiana pines.

TABLE III.—PROPERTIES OF PHENOLIC MOLDING COMPOSITIONS MADE WITH COMMERCIAL WOODFLOUR AND EXPERIMENTAL CORNCOB FLOURS

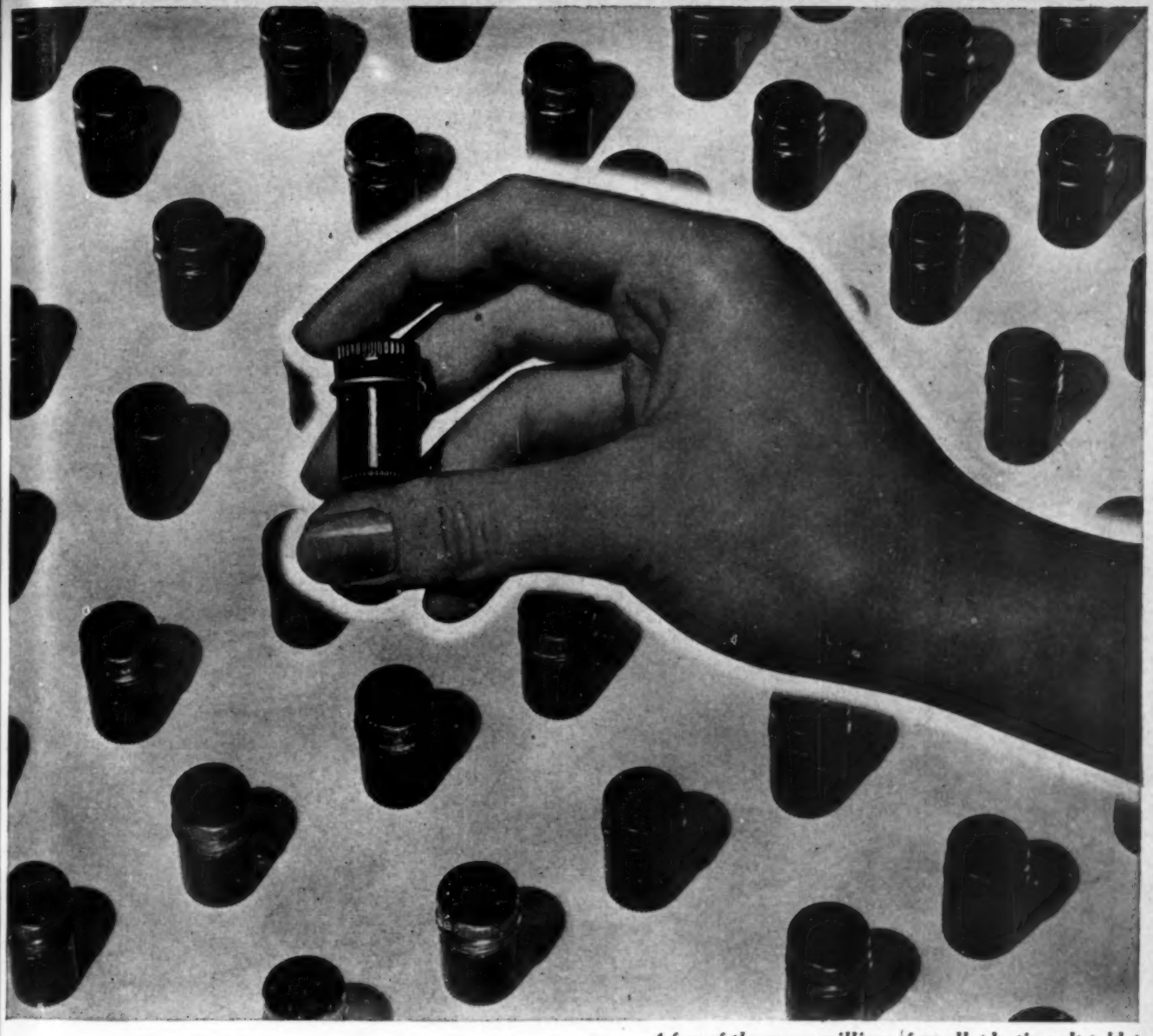
| *Composition* | *Flexural strength* | *Tensile strength* | *Impact strength, notched Izod* | *Water absorbed (24 hr. immersion at 70° F.)*[a] |
|---|---|---|---|---|
| | *p.s.i.* | *p.s.i.* | *ft.-lb./in. of notch* | *percent* |
| Woodflour, commercial | 11,490 | 7380 | 0.22 | 0.33 |
| Granular corncob flour | 12,085 | 8900 | 0.20 | 0.59 |
| Fibrous corncob flour | 11,990 | 8490 | 0.25 | 0.66 |

[a] Values are for 2-in. diameter disks, 1/8 in. thick, molded for 2 1/2 minutes

TABLE IV.—PROPERTIES OF FLAX SHIVE COMPOSITIONS WITH VARIED RESIN CONTENT

| *Composition* | | *Flexural strength*[a] | *Tensile strength*[a] | *Impact strength, notched Izod*[a] | *Water absorbed (24 hr. immersion at 70 °F.)*[b] | *Resistance to cracking*[c, d] |
|---|---|---|---|---|---|---|
| *Resin* | *Fiber* | | | | | |
| *percent* | *percent* | *p.s.i.* | *p.s.i.* | *ft.-lb./in. of notch* | *percent* | *min.* |
| 55 | 42.1 | 10,487 | 7853 | 0.19 | 0.27 | 1 |
| 47.2 | 50 | 9,530 | 7470[e] | 0.20 | 0.36 | 2 1/2 |
| 35 | 62.3 | 8,250 | 7410 | 0.18 | 0.76 | 2 |
| 30 | 67.3 | 7,663 | 7730 | 0.25 | 0.82 | 2 1/2 |
| 25 | 72.3 | 7,384 | 7038 | 0.22 | 1.04 | [f] |

[a] Molding time, 7 minutes.
[b] Values are for 2-in. diameter disks, 1/8 in. thick, molded for 2 1/2 minutes.
[c] Time shown is the molding period required to obtain 28-mm. bottle caps that withstood cracking following 15-min. immersion in boiling water, and drying at room temperature for 4 weeks.
[d] Specimens which do not crack after 2 min. molding are equal to prewar commercial compositions.
[e] Preheating molding powder previous to molding gave tensile strength of 9360 p.s.i. Other compositions in the table were not improved by preheating.
[f] Cracked after 5-min. molding.



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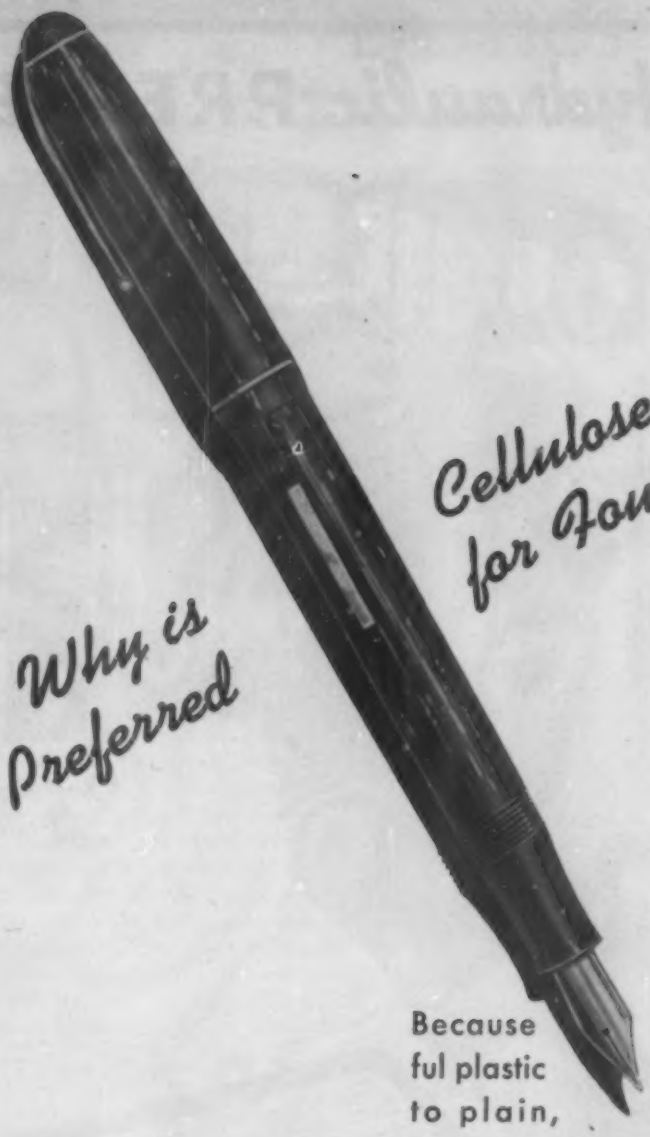

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# PLASTICS DIGEST

**This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals directly to publishers.**

## General

APPLE SYRUP BY ION EXCHANGE PROCESS. R. E. Buck and H. H. Mottern. Ind. Eng. Chem. *37*, 635-9 (July 1945). The removal of most of the malic acid from apple juice by anion adsorption avoids the bitter aftertaste of calcium malate formed by liming the original juice in the preparation of apple syrup. Anion adsorption also removes the arsenic from spray residue. Lead is almost completely removed in the final step of liming and is not a serious problem. Three methods of treatment were tested. From the standpoint of flavor the simplest treatment with a single anion exchange is the most practical. It removes about 80 to 90 percent of the acid and produces a palatable syrup with little flavor other than that of sweetness. A variable amount of arsenic is removed by the single treatment. To ensure more complete removal when it becomes necessary, a two-step (cation-anion) or a three-step (anion-cation-anion) exchanger treatment must be used. As much as 96 percent of the arsenic content was removed by the three-step method and a smaller amount was eliminated by the two-step method. In addition, the cation exchanger removes about 90 percent of the ash.

ARTIFICIAL BRISTLES FROM PROTEINS. T. L. McMeekin, T. S. Reid, R. C. Warner and R. W. Jackson. Ind. Eng. Chem. *37*, 685–8 (July 1945). A method is described for producing coarse fibers from casein by extruding a heated mixture of casein and water through a suitable die. When the fiber is stretched and hardened, under tension, with quinone, a bristle material is obtained, which is being tested in certain types of brushes.

UTILIZATION OF LIGNIN IN PLASTICS. H. Schwartz. Pulp Paper Mag. Can. *45*, 675–8 (1944). The developments in the use of lignin in plastics are reviewed. The present position and future prospects of these developments are considered. The future prospects are not promising except in the production of low-priced laminates and board products.

PRINTING ON PLASTICS. J. Simonds. Modern Packaging *18*, 97–9 (June 1945). The factors to be considered in printing on plastics are (1) type of plastic, (2) form of plastic and method of forming, (3) method of printing, (4) type of ink, and (5) method of drying.

SUGAR AND SUGAR BY-PRODUCTS IN THE PLASTICS INDUSTRY. L. Long, Jr. Sugar Research Foundation (N. Y.), Sci. Rept. Series No. 1, 5–62 (Apr. 1945). This is a review with 160 references.

## Materials

INFLUENCE OF CONDITIONS OF PREPARATION OF ALKALI-CELLULOSE ON THE PROCESS OF SYNTHESIS OF SIMPLE ETHERS AND ON THE PROPERTIES OF THE FINAL PRODUCT. S. N. Ushakov and N. V. Orlova. J. Applied Chem. (U.S.S.R.) *17*, 193–203 (1944); Chem. Abstracts *39*, 2871 (July 10, 1945). Cotton linters react completely with 20 percent alkali in 20 minutes to form alkali cellulose. Ethylation of the aged alkali cellulose gives a more soluble product than ethylation of the unaged product. When the alkali cellulose is aged in the presence of potassium chloride the solubility in benzene-alcohol mixture is increased; the ethoxy content of the product is higher. Ethylation of cellulose treated with 50 percent alkali gives a product of greater solubility and higher ethoxy content than that produced by ethylation of cellulose treated with 20 percent alkali. Addition of the ethyl chloride in several portions produces a superior grade of ethyl cellulose. Treatment of aged and unaged alkali cellulose with benzyl chloride when the alkali concentration is high produces benzyl cellulose of a higher degree of substitution than that produced at low alkali concentrations.

VIBRATORY GRINDING OF MACROMOLECULAR SUBSTANCES. E. Steurer. Plastics (London) *9*, 335–40 (July 1945). This is a translation of an article which appeared in Die Chemische Technik *16*, 1–3 (1943). High molecular weight materials were ground in a vibratory grinder and examined. Two distinctly different effects were found. One effect was of a mechanical nature. In the case of cellulose the micellar structure was broken down and changes in the arrangement of the molecules in the coherent region were observed. The other effect was of a chemical nature. This was shown by a marked decrease in the viscosity of cellulose, cellulose derivatives and several synthetic resins as a result of grinding. The force and energy aspects are discussed. Eighteen references are given in the article.

THE USE OF VARIOUS PAPERS IN PAPER LAMINATES. R. W. Barber. Paper Trade J. *120*, 46–9 (May 10, 1945). Cellulose fibers are used in many forms in the manufacture of plastics, the end use being the factor determining the qualities required. A summary is given of the materials used in the manufacture of paper laminates. The construction and the characteristics of the fiber of the paper used as the base are most important to the strength properties of the plastic. Formation, furnish, tensile strength, density, and absorbency are of particular interest. The uses of paper laminates are many and varied and can be expected to increase. Typical uses considered pertain to their application in refrigerators, aircraft flooring, and die construction.

HORN WASTE AS RAW MATERIAL FOR THE PLASTICS INDUSTRY. S. S. Bhatnagar, A. Jogarao and L. C. Verman. J. Sci. Ind. Research India *2*, 166–71 (1944). Processes for the production of molding powders from hoofs and horns are described. The most promising materials are the reaction products of horn powder, urea and formaldehyde.

PLASTICIZING OF VINYL POLYMERS. J. Harvey. Distrib. Elect., 318–24 (Oct. 1944). The factors involved in selecting plasticizers for vinyl resins are discussed. The various theories for explaining the mechanism of the plasticizing action are reviewed.

ARALAC. D. G. Carmichael. Am. Dyestuff Reporter *34*, 171–6 (Apr. 23, 1945). The history, manufacture, properties, processing and dyeing of the casein fiber, Aralac, are discussed.

## Molding and fabricating

"PLASTACK" CONTOUR PROCESS. Aero Digest *49*, 135–6, 138, 140 (June 1, 1945). A free-blowing process for forming acrylic plastic sheet to selected contours is described.

CORRECT DESIGN INSURES OPTICAL EFFICIENCY OF ACRYLIC PARTS. Product Eng. *16*, 415–17 (June 1945). Various design features for insuring the optical efficiency of transparent parts made of methyl methacrylate plastic are described and illustrated.

## Applications

DEVELOPMENT OF MOLDED FIBER GLASS FOR PRIMARY AIRCRAFT STRUCTURES. G. B. Rheinfrank, Jr., and W. A. Norman. Aero Digest *50*, 72–5, 139 (Aug. 1, 1945). Developments in the use of high strength fibers in combination with contact-pressure low-temperature thermosetting

resins opens an entirely new field for the fabrication of primary aircraft structures from laminates, which had heretofore been restricted to use in non-structural parts such as fairings, fillets and doors. To prove the feasibility of the material and the process, the AAF at Wright Field fabricated the aft fuselage section of a BT-15 airplane by a low-pressure technique using a resin-impregnated glass cloth and balsa-wood-core sandwich construction. Tests showed glass fiber to be superior to cotton, linen, rayon and silk fibers from the point of view of strength/weight ratio, uniformity, impact resistance and moisture absorption. Use of ECC-112 glass cloth was indicated for minimum gage requirements. Tests of tensile and compressive strengths and of elastic moduli using cross-lamination of alternate plies showed a 75 percent reduction of elastic modulus when tested at a 45° angle to the laminations. Compressive strengths at a 45° angle fell to 60 percent and tensile strengths to 45 percent. A series of tests with alternate plies laminated at 45° angles reduced the modulus too greatly, even though the directional properties were equalized. Computations of principal stresses showed that angles of 11° on either side of the longitudinal axis of the fuselage would be most critical. A third series of tests with alternate plies at 12° left and 12° right of the longitudinal axis, showed a reduction of 40 percent in the modulus of elasticity at 45° angle compared with a drop of 75 percent for the cross laminated.

NEW PLASTIC LAMINATE FOR AIRCRAFT PARTS. Automotive and Aviation Ind. *92*, 37, 67 (June 1, 1945). A new low-pressure plastic laminate, Conolon, is being used at Consolidated Vultee Corp. Type C is reinforced with high-strength cellulose fibers; type F employs extremely fine filaments of Fiberglas; type FC is a combination. The laminating resin used in connection with all three types is produced by combining thermoplastic and thermosetting resins. Detailed laminating and curing directions are given. Despite the low specific gravity of 1.64, Conolon is said to develop a maximum tensile strength of 120,000 p.s.i. and a compressive strength of 56,000 p.s.i. Good resistance to ordinary acids, alkalis, solvents, to impact and to vibration are indicated.

POLYISOBUTYLENE TANK LINING. D. W. Young and W. C. Harney. Ind. Eng. Chem. *37*, 675–8 (July 1945). A process for the manufacture of high-molecular-weight polyisobutylene compositions is described. Available laboratory data show that such a compounded polymer would be an excellent tank lining. A method was developed to bond the polyisobutylene lining to steel. Adhesion of the polymer film to steel is approximately 760 lb./in² at room temperature. High loadings of carbon black produce good adhesion or interlocking of this linear type polymer to steel when cyclized rubber cement is applied as an intermediate bonding agent. Further data show the resistance of the lining to concentrated and dilute solutions of acids and alkalis at room temperature. Except in a few instances the compounded polymer linings show no tendency to blister at 100° C.

THE USE OF COLUMBIA RESIN AS AN OPTICAL CEMENT. H. W. Coles, H. Deuberry and F. P. Curry. J. Optical Soc. Am. *34*, 623–5 (Oct. 1944). The use of Columbia Resin CR-39 (PKR-15) as an optical cement appears to be satisfactory for both small and large lenses and prisms. Lenses and prisms cemented with this resin have successfully passed all the usual tests applied to such lenses and do not shatter at very low temperatures. The results of the tests indicate that the substitution of this resin for balsam cement is an important contribution in the search for a cold-resistant optical cement.

WOOL SHRINKAGE CONTROL WITH RESINS. J. E. Lynn. Textile World *94*, 89–91 (Dec. 1944). All-wool and part-wool fabrics both woven and knitted are treated with a water-soluble melamine resin and converted to an insoluble resin by heat. The shrinkage and effect of alkali are reduced. The process is described in detail.

PHENOLIC VIALS SOLVE A QM PROBLEM. R. S. Couch. Modern Packaging *18*, 103–5 (July 1945). Vials molded of a phenolic plastic are used to package Halozone, Bursoline and salt tablets for inclusion in the C and K Ration Kits. The results of tests indicate that these containers are satisfactory.

ETHYL CELLULOSE SHEETING. F. C. Dulmage, Jr., and F. J. MacRae. Modern Packaging *18*, 142–5 (July 1945). The properties of ethyl cellulose sheeting are reviewed. Fabrication techniques for making packages and containers of this material are described.

WANTED — A PLASTIC DIP-COATING FOR CARTONS. Modern Packaging *18*, 131 (July 1945). The desired characteristics of a plastic dip-coating for cartons wanted by the Office of the Quartermaster General, War Department are given.

### Coatings

RESIN COATINGS BAKED BY INDUCTION HEATING. A. P. Mazzucchelli and R. E. Nicolson. Iron Age *155*, 46–50 (May 3, 1945). The curing of phenolic resin coatings on metals by induction heating is discussed A method for coating pipe and the subsequent curing of the resin as it is pulled out of the resin bath through an induction furnace is described.

NEW BASES FOR COATING AND PLASTIC COMPOSITIONS. P. L. Nichols, Jr., R. M. Hamilton, L. T. Smith and E. Yanovsky. Paint Industries Mag. *60*, 84, 86, 88, 90 (1945). The allyl ethers of several polyhydric alcohols were investigated. Methods of preparation and properties are described. The products are considered for use in the formulation of coatings, adhesives and also plastic intermediates.

WAR DEVELOPMENTS IN THE COATINGS INDUSTRY. L. Auer. Chemical Industries *57*, 257–9, 325 (Aug. 1945). This is a review of the application of organic coatings in war equipment.

LAC DERIVATIVES AS RESIN PLASTICIZERS FOR CELLULOSE LACQUERS. B. S. Gidvani and N. R. Kamath. Paint Manuf. *15*, 93–7 (1945). The alkyl, glycol and glycerol esters of lac were investigated for use as plasticizers for cellulose nitrate lacquers. The results indicate that these compounds have advantages for this application.

WATER PAINTS IN THE POST-WAR ERA. C. Iddings. Am Paint J. *29*, Nos. 28, 62, 64, 68, 70, 72 ,74, 76 (1945). The advantages and disadvantages of water emulsion paints are reviewed in these articles.

SYNTHETIC RESINS AND THE DRYING OILS. W. R. Catlow, Jr. Oil & Soap *22*, 131–2 (1945). Synthetic resins used in coating formulations are discussed herein.

MAGNETIC EASEL FOR USE IN SPRAYING TEST PANELS. T. H. G. Michael. Ind. Eng. Chem. Anal. Ed. *17*, 464 (July 1945). A magnetic easel for holding metal test panels while they are being coated by spraying is described.

DETERMINATION OF MODULUS OF ELASTICITY OF VARNISH FILMS. EFFECT OF WATER IMMERSION. H. G. Steffens. Ind. Eng. Chem. Anal. Ed. *17*, 417–18 (July 1945). A method is described for measuring the change in modulus of elasticity of detached varnish films during water immersion, using an improvised tensiometer of simple design. Special reference is made to insulating varnishes. Data on immersion characteristics of a typical air-drying varnish are included.

TESTS FOR ABRASION, ADHESION, FLEXIBILITY, AND HARDNESS OF TRAFFIC PAINTS. C. W. Allen. ASTM Bull. No. *130*, 29–36 (1944). The results of abrasion, adhesion, flexibility and hardness tests of traffic paints are described. Abrasion and combined abrasion-accelerated weathering tests correlated with service behavior. The adhesion, flexibility and hardness tests show no correlation with field service behavior.

# TECHNICAL BRIEFS

**Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments.**

## Engineering

METAL RECOVERY BY ANION EXCHANGE. S. Sussman, F. C. Nachod and W. Wood. Ind. Eng. Chem. *37*, 618–24 (July 1945). Chromium, gold, iron, molybdenum, palladium, platinum, and vanadium, in the form of complex anions, were recovered from dilute solutions by anion exchange utilizing synthetic resins. The process is independent of the valence of the complex anion and of the nature of the nonmetallic elements included in the complex anion. Recovery of the adsorbed anions was effected by a number of reagents, but alkaline solutions are most effective. The concentration of the complex anion in the recovery effluent was more than 20 times that in the influent.

SYNTHETIC ION EXCHANGE RESINS IN THE SEPARATION, RECOVERY, AND CONCENTRATION OF THIAMINE. D. S. Herr. Ind. Eng. Chem. *37*, 631–4 (July 1945). The adsorption, separation, and concentration of thiamine by the acid-regenerated form of a synthetic ion exchange resin were studied. An adsorption column technique, utilizing resin with a particle size near 0.40 mm. rather than the usual finely powdered material, completely removes thiamine, for which the resin has a large capacity, in the presence of riboflavin. Since riboflavin is not adsorbed under the conditions in which thaimine is completely removed, the separation is satisfactory. The vitamin is eluted in excellent yields by passage of strong mineral acid through the column, although other reagents may be used to advantage in specific instances. These results are achieved with percolation rates equivalent to as much as 5 gal. ft.$^2$ min. with beds no greater than 0.5 ft. in depth. The practicability of the process has been demonstrated by the recovery of thiamine from rice bran extracts. The resin stability, particularly in strong acids, makes possible its application where such pH conditions are necessary to protect products from alkaline degradation.

INSECTS—THEIR RELATION TO PACKAGES AND PACKAGING MATERIALS. E. O. Essig. Modern Packaging *18*, 135–41, 182 (July 1945). The results of insect penetration tests on packaging materials are reported. The materials include metals, papers, cellophane, and waxes.

ULTRASONICS. THEIR SCIENTIFIC AND INDUSTRIAL APPLICATIONS. S. Parthasarthy and A. Pande. J. Sci. Ind. Research (India) *3*, 308–20 (1945). This is a review article with 85 references.

## Chemistry

THE DETERMINATION OF MOLECULAR-WEIGHT DISTRIBUTION IN HIGH POLYMERS BY MEANS OF SOLUBILITY LIMITS. D. R. Morey and J. W. Tamblyn. J. Applied Phys. *16*, 419–24 (July 1945). By means of polymer fractions of known molecular weight, dissolved in solutions of known compositions, it is possible to determine the solubility law which relates the point of solution saturation to the molecular weight and concentration of the dissolved polymer. Having established such a calibration, it is possible to determine the molecular weight distribution in a heterogeneous sample of the polymer by suitable operation on a curve relating the mass of polymer precipitated to the amount of precipitant added to the solution. Optical means, making use of scattering from the precipitate, are used to obtain this latter curve. The method is applied to cellulose acetate butyrate and is shown to give results in agreement with gravimetrically obtained distribution curves.

CALORIMETRIC STUDY OF GELATINIZATION OF CELLULOSE NITRATES BY ACETIC ESTERS. E. Calvet. Compt. rend. *217*, 482–3 (1943); Chem. Abstracts *39*, 2690–1 (July 10, 1945). By a microcalorimetric technique, the quantities of heat liberated by the fixation of liquid acetic esters by cellulose nitrate were measured directly. A cellulose nitrate containing 40 percent nitrogen in methyl and ethyl acetates and one containing 11.5 percent nitrogen in methyl, ethyl, propyl and butyl acetates were studied. The ratio of the change in heat content with change in the moles of solvent fixed decreases as the length of the solvent molecule increases; this ratio varies from 5300 cal/g for methyl acetate to 1000 cal/g for butyl acetate. An abrupt change in slope of the curves expressing the change of heat content as a function of the number of moles of solvent fixed per glucoside unit occurs when the moles of solvent is between 1.5 and 2; some curves become less horizontal and others more horizontal.

INFLUENCING THE RATE OF SOLIDIFICATION OF ORGANIC SILICON GLASSES. L. Holzapfel, J. Kerner and H. Neuhaus. Glastech. Ber. *21*, 13–14 (1943); Chem. Abstracts *39*, 2051 (May 20, 1945). The effect of various nitrogen and hydroxyl organic compounds on the rate of solidification of the liquid organic silicic acid esters was investigated.

## Properties

A COMPARISON OF SOME ELASTIC TIRE CORDS. H. Wakeham, E. Honold and E. L. Skau. J. Applied Phys. *16*, 388–401 (July 1945). Additional information concerning the elastic properties of tire cords is needed since the present criteria involving breaking strength and elongation are considered insufficient to enable prediction of tire cord performance. The elastic behavior of nylon, of rayon, and of unstretched and stretched cotton tire cords are compared with respect to their rates of elongation during measurement of the stress-strain curves and their elongation under static loads at various temperatures between 25° and 200° C. Elongations under the influence of cyclic loads are shown for cotton and rayon cords, and an apparatus for determining mechanical hysteresis of tire cords during cyclic loading is described. The temperature and moisture content of the cord shown have considerable effect upon its elastic properties.

THE RELATIONSHIP BETWEEN THE RHEOLOGICAL PROPERTIES AND WORKING PROPERTIES OF PRINTING INKS. R. Buchdahl and J. E. Thimm. J. Applied Phys. *16*, (June 1945). It is shown that the working properties of a printing ink, i.e., its performance during the printing operation, can be interpreted in terms of the rheological properties as measured in a rotational viscosimeter. The instrument used in this investigation is a viscosimeter of the Stormer type. Data are presented to show that it is necessary to distinguish between time-dependent and time-independent flow phenomena. Various theories suggested to explain the time-independent flow phenomena are discussed briefly. The flow of a printing ink over the main mechanical elements of a typographic printing press is analyzed and correlated with simpler flow phenomena which can be measured in a rotational viscosimeter.

ON THE RHEOMETRY OF ORGANIC GLASSES. I. W. Scheele, M. Alfeis and L. Lahaye. Kolloid-Z. *103*, 1–7 (Apr. 1943). Changes in the rheology caused by addition of plasticizers, changes in the degree of polymerization and variations in the temperature were investigated. The four different types of flow curves,

pure viscous, pure plastic, quasi-viscous and quasi-plastic, are discussed. The areas between the flow curve, the velocity axis, and a parallel to the shearing-stress axis is termed the "deformation power." The deformation power depends on temperature in a manner similar to the Andrade-Sheppard relation for viscosity. Flow curves for polyvinyl acetate plastics at various temperatures are presented.

DIELECTRIC PROPERTIES OF LACS. G. N. Bhattacharya. Indian J. Phys. *18*, 97–134 (1944). The dielectric properties of purlac, soft lac, lac-wax, mixtures of hard and soft lac, shellac-urea-formaldehyde resin and shellac-melamine-formaldehyde resin were measured over a wide range of temperatures and frequencies.

PLASTICS AND ELASTICS. L. Hartshorn. British Plastics *17*, 99–106 and 186–92 (Mar. and May 1945). The electrical properties of plastics and elastic materials are reviewed. Eighteen references.

### Testing

TESTS SHOWING THE SUITABILITY OF PULPS FOR THE PRODUCTION OF CELLULOSE ACETATE. G. Jayme and U. Schenck. Cellulose-Chem. *22*, 54–6 (1944); Chem. Abstracts *39*, 2402 (June 10, 1945). Test methods for determining the initial turbidity value, final turbidity value and the undissolved residue of the reaction product when wood pulp is treated with glacial acetic acid are described. The difference between the initial turbidity value and the final turbidity value and the magnitude of the undissolved residue indicate whether or not the pulp is suitable for the production of cellulose acetate.

AN ISOTHERMAL CALORIMETER AND ITS APPLICATION TO METHYL METHACRYLATE. L. K. J. Tong and W. O. Kenyon. J. Am. Chem. Soc. *67*, 1278–81 (Aug. 1945). A simple isothermal calorimeter is described which is suitable for determination of heats of polymerization. Its operation using methyl methacrylate is illustrated. The heat of polymerization of methyl methacrylate was found to be $13.0 \pm 0.2$ kcal/mole. This value did not change with temperature or catalyst concentration within the limits investigated. The rate of polymerization as measured by heat evolution agrees with measurements of other investigators using other methods.

A STUDY OF CONSTANT-STRESS RHEOMETERS. J. E. Caffyn. J. Sci. Instrum. *21*, 213–16 (Dec. 1944). Rheometers in which the tensile or compressive force changes as the cross-sectional area of the sample changes are made by utilizing a bent lever to apply the force. Equations for the operation of these rheometers are developed. The amount of deformation, the dimensions of the sample and the working range of the instrument are related for deformations at constant volume.

EQUIPMENT FOR TENSILE TESTING AT ELEVATED TEMPERATURES. D. R. Scheu and J. W. Schade. India Rubber World *112*, 65-6 (Apr. 1945). A pendulum-type tensile testing machine is housed in an insulated cabinet so that tests could be made up to 300°F.

RADIOGRAPHY OF PLASTICS. S. D. Amidon. Ind. Radiography *3*, Nos. 4, 21–3 (1945). Several applications of radiographic methods to the control of the quality of plastic products are described in these articles.

DURABILITY TESTER FOR COATED OPTICAL ELEMENTS. M. G. Townsley. Rev. Scientific Instr. *16*, 143–6 (June 1945). Military use of thin films of various types coated on optical elements has made it necessary to raise the abrasion resistance of these coatings to the maximum possible value. Research on the measurement and improvement of abrasion resistance has been handicapped by the lack of a suitable reproducible testing method. This article describes a reproducible, semi-quantitative testing method for measuring the abrasion resistance of thin films coated on optical elements.

A FLOW-CURVE RECORDER FOR A ROTATIONAL VISCOMETER. R. N. Weltmann. Rev. Scientific Instr. *16*, 184–91 (July 1945). In the study of thixotropic substances and of materials of non-Newtonian behavior, it is important to obtain complete flow curves (rate of shear versus shearing stress) which are taken in accordance with a standardized procedure. The time interval for any given increase or decrease in rate of shear should remain constant. A recorder which draws complete flow curves was developed as an attachment for a Couette type of viscometer. The deflection of the bob, which is proportional to the shearing stress, is plotted against the speed (revolutions per minute) of the cup which is proportional to the rate of shear. For precise measurements the bob suspension spring must not be subjected to any friction load; therefore the recorder uses sparks generated by a high voltage to puncture the recording paper. The sparking electrode is moved by the bob deflection spring while the paper is moved perpendicularly to the electrode motion by the transmission handle, the position of which controls the cup speed. A number of measurements made with the recorder are shown. The recorded flow curves permit immediate interpretation and calculation (without any replotting) of the plastic viscosity, the yield value, and the thixotropic behavior of the tested materials. A method is proposed for determining the plastic viscosity and the yield value at initial agitation, which are identified as the initial thixotropic viscosity and the initial thixotropic yield value.

### Synthetic rubber

SYNTHETIC RUBBER AND ITS USE IN THE AIRPLANE. J. B. Hutson. Rubber Age *57*, 437–41 (July 1945). The various uses of synthetic rubber in aircraft construction are reviewed. The approximately 1600 items are classified into the following categories: tires and tubes, fuel cells and tanks, hose and tubing, vibration insulators, and miscellaneous parts such as gaskets, washers, packing, etc. Ester-type plasticizers in rubber windshield gaskets cause crazing of methyl methacrylate plastic where the gasket comes in contact with the plastic.

OBJECTIVE LABORATORY TESTING OF THE PROCESSABILITY OF ELASTOMERS. L. M. White, E. S. Ebers and G. E. Shriver. Ind. Eng. Chem. *37*, 767–9 (Aug. 1945). An analysis was made of the types of adverse behavior encountered in compounding and fabricating dry-mixed elastomers on a factory scale, with an attempt to ascribe the different modes of behavior to semi-fundamental properties of the elastomer and its compounds. On the basis of this analysis, four simple tests, namely filler stiffening, compound viscosity, length shrinkage, and rugosity are proposed for determining the processing properties of elastomers on a laboratory scale. Extended correlations of predictions made from these tests with factory data demonstrate their reliability and usefulness in laboratory evaluation of new rubberlike materials.

MICROSCOPIC STUDIES OF LYOGELS. E. A. Hauser and D. S. le Beau. Ind. Eng. Chem. *37*, 786–9 (Aug. 1945). A new technique is described which permits the microscopic examination of lyogels, particularly of natural and synthetic rubber, with ultra-illumination by incident light. The morphology of the original lyogel and that of its fractions, separated by solvent extraction, can be studied, as well as the changes it undergoes when subjected to chemical reaction or physical forces. Results so far obtained by this technique in the study of natural and synthetic rubbers, soap, and other lyogels are discussed. Several photomicrographs are reproduced as examples of the applicability and versatility of this simple technique for studying the morphology of lyogels.

SYNTHETIC RUBBER. Chem. Ind. *57*, 260–4 (Aug. 1945). This is a summary of a report issued by the Rubber Reserve Company covering its activities from 1940 to 1945, describing the increase in production from 3600 to 1,000,000 tons per year in four years.

# U. S. Plastics Patents

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 10 cents each.

SPINNERET. B. Wempe (to Alien Property Custodian). U.S. 2,376,742, May 22. A molded plastic spinning nozzle.

BOAT. K. H. Bowen (to Columbian Rope Co.). U.S. 2,376,753, May 22. A boat formed of a molded composition.

COATING. P. H. Scrutchfield (to Hercules Powder Co.). U. S. 2,376,823, May 22. A coating composition comprising a drying or semidrying oil, and the reaction product of a polyhydric alcohol and a conjoint reaction product of a rosin acid or lower monohydric alcohol ester thereof, an aldehyde, and an alpha, beta-unsaturated polycarboxylic acid.

CEMENT. S. G. Saunders and H. Morrison. U.S. 2,376,854, May 22. A cement comprising a dispersed mixture of a synthetic rubber such as chloroprene polymers or butadiene acrylic nitrile copolymers, a thermosetting synthetic resin, and a solvent for the resin.

CELLULOSE ESTERS. F. P. Alles (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,376,890, May 29. Freshly coagulated cellulose acetate is impregnated with corn syrup before drying.

CELLULOSE ESTERS. F. P. Alles (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,376,891, May 29. The affinity of cellulose acetate yarn for direct acid and chrome dyes is retained by impregnating the yarn in the gel stage with polytriglycol adipamide.

SYNTHETIC YARNS. P. W. Morgan (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,376,934, May 29. Filaments, yarns, sheets, etc. of synthetic material are rendered receptive to direct acid and chrome dyes by treating before coagulating with glycol polyformal and a basic trivalent nitrogen compound.

FABRIC. W. I. Taylor and J. F. Levers. U. S. 2,376,983, May 29. Fabrics resembling animal pelts are prepared by subjecting a pile fabric having flat filaments of a cellulose ester to the crinkling action of a boiling aqueous medium.

JOINING MEANS. C. W. Leguillon and H. L. Young (to B. F. Goodrich Co.). U. S. 2,377,018, May 29. An apparatus for joining a plastic body to an adjoining body of yieldable material.

DENTAL LINER. S. Rogover. U.S. 2,377,041, May 29. A liner for dentures comprising a methyl methacrylate resin plasticized with the acetic acid ester of glycerine.

DECORATIVE ARTICLE. A. Rosenthal. U.S. 2,377,042, May 29. A decorative plastic article comprising a transparent elongated tube having a helically fluted exterior and a hollow internal channel of elliptical cross-section.

GLASS LAMINATE. L. D. Keslar (to Pittsburgh Plate Glass Co.). U.S. 2,377,084, May 29. A laminated glass structure comprising two sheets of glass and an interposed thermoplastic layer which extends beyond the glass thus serving as a flexible attaching flange.

PHTHALATE DERIVATIVES. I. E. Muskat (to Pittsburgh Plate Glass Co.). U.S. 2,377,095, May 29. An insoluble infusible polymer is prepared by polymerizing an unsaturated alcohol polyester of phthalic acid, interrupting the reaction, separating residual monomer, subjecting to sufficient temperature and pressure to insure the existence of the polymer in the fused state, and continuing the reaction to the fully cured state.

POLYVINYL ACETAL. E. R. Derby (to Monsanto Chemical Co.). U.S. 2,377,214, May 29. A plastic composition comprising a polyvinyl butyral resin which has been plasticized with triethylene glycol dibutyrate.

PLASTIC. R. F. Hayes (to Monsanto Chemical Co.). U.S. 2,377,231, May 29. A decorative article is prepared by heat softening and incorporating in polystyrene a vinyl resin containing an ether or ester linkage which due to incompatibility gives an opalescent effect.

OPTICAL SYSTEM. H. Rinia (to Alien Property Custodian). U.S. 2,377-268, May 29. A correction element of synthetic resin for use in an optical system having spherical aberrations.

STRUCTURAL MATERIAL. D. Finlayson and F. C. Hale (to Celanese Corp. of America). U.S. 2,377,335, June 5. A stress-resisting member having a cross-section enabling it to have lateral rigidity, consisting of textile yarns embedded in plastic material of low elasticity.

COATING DEVICE. L. M. Wiley (to R. B. Wiley and J. T. Lett). U.S. 2,377,393, June 5. A method for forming a plastic coating on a preformed fibrous core by extrusion in a molding device.

UREA RESINS. T. S. Hodgins and P. S. Hewett (to Reichhold Chemicals, Inc.). U. S. 2,377,422, June 5. Clear, stable, water-white, hydrocarbon-soluble, rapidly heat-convertible, alcohol-modified, urea-formaldehyde resin condensates are prepared by reacting urea and formaldehyde in the presence of an alkaline catalyst, distilling under a pressure of 30 to 100 mm. of mercury until a clear syrup is obtained, reacting with a primary alcohol in the presence of an acid and distilling under pressure until soluble in a straight chain hydrocarbon.

TEXTILE. A. Lyem (to Celanese Corp. of America). U.S. 2,377,434, June 5. Cellulose derivative yarns are treated to improve their serimetric properties by passing through a solution of acetaldehyde and xylene, and immediately evaporating to dryness.

CELLULOSE NITRATE. R. H. McKee. U.S. 2,377,435, June 5. Cellulose nitrate is prepared by adding finely divided cellulose to a weak nitrating bath simultaneously with a fine spray of the acid, continuously removing used acid and adding unused until all cellulose is added, circulating weak acid, adding and circulating strong acid through a cooling system, and finally washing.

FLY SWATTER. V. J. Mueller. U.S. 2,377,439, June 5. A fly swatter blade comprising a reticular screen of plastic filaments.

SEMI-CONDUCTOR. H. H. Barker and L. R. Hill (to Westinghouse Electric Corp.). U.S. 2,377,600, June 5. An electrically semi-conducting composition comprising a colloidal suspension of anthracite coal particles in a phenyl ethyl silicone polymer.

COATING DEVICE. H. R. Crane. U.S. 2,377,615, June 5. A tool for dispersing a uniform coating of a plastic liner on the inner walls of a conduit.

COMPACT. A. F. Reilly (to Evans Case Co.). U.S. 2,377,717, June 5. A compact of decorative plastic material.

RESIN. T. C. Whitner (to Chemical Laboratories, Inc.). U.S. 2,377,734, June 5. A resin is prepared by polymerizing a liquid water-soluble condensate of an aliphatic aldehyde with an aliphatic ketone to a water insoluble solid with tetra alkylol ammonium hydroxide used as a catalyst.

POLYMERIZATION PROCESS. J. W. Britton and R. C. Dosser (to Dow Chemical Co.). U.S. 2,377,751, June 5. In preparing polyvinyl halides a polymerization mixture is prepared consisting of the monomer, an acid, a peroxide, a ferric compound and a solvent medium.

POLYMER. M. M. Brubaker (to E. I. du Pont de Nemours and Co., Inc.). U.S. 2,377,753, June 5. A copolymer of ethylene with a vinyl thioester of an organic carboxylic acid.

RESIN. G. F. D'Alelio (to General Electric Co.). U.S. 2,377,761, June 5. A resin comprising the reaction product of a chlorinated acetamide and a partial condensate of a urea having at least two hydrogen atoms attached to the nitrogen atoms and being free of N-methylol groups and a preformed methylol urea.

ETHYLENE POLYMER. W. E. Hanford, J. R. Roland and H. S. Young (to E. I. du Pont de Nemours and Co., Inc.). U.S. 2,377,779, June 5. Polymers are produced by heating ethylene in a solvent in the presence of an alkyl or aryl lithium compound and a little oxygen.

VINYLIDENE CHLORIDE POLYMERS. W. B. Robbins (to Dow Chemical Co.). U.S. 2,377,810, June 5. A crinkled filament of vinylidene chloride is produced by spraying with a cold nonsolvent liquid while the filament is at 90°C. or higher and subsequently cold-stretching.

METHYL CELLULOSE. P. R. Wenck (to Dow Chemical Co.). U.S. 2,377,834, June 5. The syneretic characteristics of methyl cellulose are reduced by the inclusion in an aqueous solution of the salt of cellulose glycollic acid.

COATINGS. J. J. Healy, Jr. (to Monsanto Chemical Co.). U.S. 2,377,840, June 5. Cellulose ester and ether lacquers are modified by a ground silica alcogel which serves as a flatting agent.

RESIN. G. F. D'Alelio (to General Electric Co.). U.S. 2,377,866, June 12. A heat-curable aminoplast intercondensed with a partial amide of a polycarboxylic acid.

RESIN. G. F. D'Alelio (to General Electric Co.). U.S. 2,377,867, June 12. The resinous reaction product of an aminotriazine, an aldehyde and sulfamic acid.

RESIN. G. F. D'Alelio (to General Electric Co.). U.S. 2,377,868, June 12. The condensation product of an aminotriazine, an active methylene-containing body and an amino compound such as amphoteric amino carboxylic and sulfonic acids, and salts thereof and mixtures of the acids and salts.

SCISSOR HANDLE. L. W. Schaaf (to Wilhelmina M. Kuhn). U.S. 2,377,906, June 12. A molded handle for replaceable blade shears.

TUBING. C. E. Slaughter (to Extruded Plastics, Inc.). U.S. 2,377,908, June 12. Thermoplastic tubing is prepared by extruding, cooling to a partially set condition, cutting, introducing a fluid to prevent collapse and floating a rigid plug of the same diameter as the bore of the tubing to maintain fluid pressure.

PETROLEUM RESIN. C. E. Adams (to Standard Oil Co.). U.S. 2,377,914, June 12. Light colored resins are produced by heating petroleum hydrocarbons at a temperature of 800 to1050°F. in the presence of a refractory metal oxide, separating a fraction having a molecular weight of 130 to 350, and subjecting this fraction to chlorination at 110 to 450°F.

ROOFING COMPOUND. C. M. Evans (to Master Mechanics Co.). U.S. 2,377,927, June 12. A liquid roof-surfacing compound comprising para-coumarone indene resin, rosin modified phenol-formaldehyde resin, mineral asphalts, drying fish oil, naphtha and a bituminous mixture consisting of liquid petroleum asphalt and asbestos fibers.

CAST MATERIAL. F. L. Fielitz and B. M. Marks (to E. I. du Pont de Nemours and Co., Inc.). U.S. 2,377,928, June 12. Cast rods of acrylic or methacrylic resins are treated by heating to the softening point, stretching, cooling under tension, cutting a curved surface body from the rod and finally heating to the softening point to permit shrinkage.

SHAPING METHOD. R. E. Leary (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,377,946, June 12. Hemispherical sections of thermoplastic resin are shaped by clamping a sheet over a negatively shaped die, evacuating the die and heating the sheet by means of a bank of infrared lamps.

JIG. P. F. Preston (to E. I. du Pont de Nemours and Co., Inc.). U.S. 2,377,962, June 12. An apparatus for cementing together a pair of curved mating parts of plastic material.

POLYAMIDES. W. W. Watkins (to E. I. du Pont de Nemours and Co., Inc.). U.S. 2,377,985, June 12. The reaction product of a monoamino-monocarboxylic acid or a diamine with a dibasic carboxylic acid.

ABRASIVE. L. Coes, Jr. (to Norton Co.). U.S. 2,377,995, June 12. An abrasive article comprising abrasive grains bonded as a porous body by means of ceramic material and a filler for the pores consisting of furfuryl alcohol polymerized with lignin.

VINYL RESIN. R. C. Houtz (to E. I. du Pont de Nemours and Co., Inc.). U.S. 2,378,015, June 12. The polyvinyl ether of beta-guanyl ethanol is prepared by reacting polyvinyl beta cyanoethyl ether in anhydrous methyl acetate at 0°C. with anhydrous methanol and hydrogen chloride, isolating the resulting polyvinyl ether of methyl 3-hydroxy propionimidate hydrochloride and reacting with ammonia in absolute ethanol.

SAFETY GLASS. W. J. Hubbard (to Libbey-Owens-Ford Glass Co.). U.S. 2,378,016, June 12. Safety glass is prepared by assembling glass and plastic laminations, rotating the assembly to effect securing by centrifugal force, simultaneously heating and then subjecting to the direct action of a heated fluid under centrifugal pressure.

ELASTOMERS. J. F. Olin (to Sharples Chemicals, Inc.). U.S. 2,378,030, June 12. An elastomer is prepared by polymerizing a conjugated diolefin hydrocarbon in an aqueous emulsion containing a tertiary alkyl mercaptan.

BALL. G. H. Perryman. U.S. 2,378,034, June 12. A method for making table tennis balls.

POLYSTRYENE. A. R. Krotzer, W. A. King and J. H. Kleiner (to Allied Chemical and Dye Corp.). U.S. 2,378,089, June 12. In producing polystyrene the polymerization is carried out in the presence of formaldehyde in order to produce a polymer with high viscosity.

YARN. J. R. Caldwell (to Eastman Kodak Co.). U.S. 2,378,183, June 12. A yarn spinning solution comprising a cellulose organic ester dissolved in a volatile solvent and containing a partially polymerized phenol-urea-formaldehyde resin prepared by condensing under alkaline conditions a phenol, a urea and formaldehyde.

TEXTILES. J. A. Clark (to Sylvania Industrial Corp.). U.S. 2,378,186, June 12. Textiles are stabilized by treating with an alkaline dispersion of an alkali soluble water insoluble cellulose ether at elevated temperatures and coagulating the cellulose ether on the textile.

VINYL COPOLYMERS. G.F. D'Alelio (to General Electric Co.). U.S. 2,378,194, June 12. An interpolymer of more than 90 percent vinyl chloride and a di-ester of itaconic acid.

POLYMERS. G. F. D'Alelio (to General Electric Co.). U.S. 2,378,195, June 12. Polymers are formed by polymerizing a solution of divinyl benzene in a dialkyl benzene in the presence of both an inhibitor and a catalyst for a period less than that required to cause gelation of the solution.

COPOLYMERS. G. F. D'Alelio (to General Electric Co.). U.S. 2,378,197,

June 12. Compositions comprising a heat-convertible, fusible partial copolymer of divinyl benzene and an allyl, methallyl, or chlorallyl ester of an unsaturated monocarboxylic acid; an allyl or methallyl unsaturated alcohol polyester of a saturated aliphatic or aromatic polycarboxylic acid; or an unsaturated ether or ketone.

CONDENSATES. G. F. D'Alelio (to General Electric Co.). U.S. 2,378,198, June 12. A composition comprising the reaction product of a chlorinated acetamide with the partial reaction product of an aldehyde and a triazine derivative.

RESINS. G. F. D'Alelio (to General Electric Co.). U.S. 2,378,199, June 12. Resinous compositions are prepared by reacting a carbonyl group containing compound with hydrolyzed thermoplastic polymer of a vinyl ester of a monocarboxylic acid or a 1-substituted derivative of guanazole.

RESIN DISPERSIONS. J. G. Little (to Hercules Powder Co.). U.S. 2,378,230, June 12. A dispersion comprising an insoluble, gelled, polycarboxylic acid-polyhydric alcohol resin dispersed in an organic liquid which is normally a solvent for the ungelled resin and morpholine as a dispersing agent.

EDGE GLUING. H. D. Pfenning (to B. P. John Furniture Corp.). U.S. 2,378,244, June 12. Wood veneers are joined in edge to edge relation by applying between adjacent edges a urea-formaldehyde resin, curing the resin by heat.

POLYVINYL ACETAL. E. R. Derby (to Monsanto Chemical Co.). U.S. 2,378,288, June 12. A polyvinyl acetal resin plasticized with a mixture of diethylene glycol dipropionate and butyl carbitol butyrate.

LAMINATE. F. C. Dulmage, Jr. and Toivo A. Kauppi (to Dow Chemical Co.). U.S. 2,378,291, June 12. A shatterproof laminar structure is prepared by integrally bonding a sheet comprising a high molecular weight acrylic or methacrylic ester to a sheet of a cellulose ether, coated with nitrocellulose, by polymerizing acrylic or methacrylic acid esters between the sheets.

INSULATION. N. R. Peterson (to Dow Chemical Co.). U.S. 2,378,322, June 12. An insulation article is prepared by treating exfoliated vermiculate with an aqueous solution of a heat-setting resin, and a cellulose ether, shaping in a mold, warming in the mold to stiffen, removing, drying and baking at 90 to 150°C.

TEXTILE FINISH. H. J. Huey and W. W. Russell (to Sayles Finishing Plants, Inc.). U.S. 2,378,360, June 12. Cotton cloth is impregnated with an alkaline solution of a cellulose derivative. Partially dried by heat, the cellulose derivative is precipitated and the cloth is shrunk with strong caustic.

MELAMINE-FORMALDEHYDE. K. E. Ripper (to American Cyanamid Co.). U.S. 2,378,362, June 12. A clear, stable aqueous syrup is prepared by reluxing a slightly acid mixture of melamine and formaldehyde until a hydrophilic sol is formed, adding dicyandiamide and an alkali, reacting below reflux temperature until the syrup is formed.

COATING. R. C. Swain and P. Adams (to American Cyanamid Co.). U.S. 2,378,363, June 12. A coating containing hydrogenated methyl abietate and a melamine-formaldehyde resin which has been reacted with ethylene chlorohydrin, a propyl alcohol, a butyl alcohol, benzyl alcohol or an octyl alcohol.

COATING. R. C. Swain and P. Adams (to American Cyanamid Co.). U.S. 2,378,364, June 12. A coating containing Batavia dammar resin and a melamine-formaldehyde resin which has been reacted with an aliphatic acyclic alcohol.

COATING. R. C. Swain and P. Adams (to American Cyanamid Co.). U.S. 2,378,365, June 12. A coating containing methyl methacrylate and an alcohol-modified melamine-formaldehyde resin.

COATING. R. C. Swain and P. Adams (to American Cyanamid Co.). U.S. 2,378,366, June 12. A coating containing a rosin-modified phenol-formaldehyde resin and an alcohol-modified melamine-formaldehyde resin.

MASTIC TILE. M. K. Bare (to Armstrong Cork Co.). U.S. 2,378-377, June 19. A preformed tile comprising a filler and a binder of a polymer of coumarone, indene or styrene, the condensate of a polyhydric alcohol and a dicarboxylic acid, and a plasticizer.

ADHESIVE. H. F. Bauer (to Stein, Hall and Co., Inc.). U.S. 2,378,378, June 19. An adhesive comprising an amylaceous substance, a water-soluble urea and a solid acid.

RESIN. A. L. Rummelsburg (to Hercules Powder Co.). U.S. 2,378,436, June 19. A resin is prepared by reacting a mixture of a phenol and a monomer or polymer of an acyclic terpene in the presence of a catalyst.

COATING. F. J. Soday (to United Gas Improvement Co.). U.S. 2,378,445-6, June 19. A coating for metal comprising a prime coat of styrene or methyl styrene-polycyclopentadiene resin and a top coat of a polyvinyl compound.

PLASTICIZER. F. J. Soday (to United Gas Improvement Co.). U.S. 2,378,447, June 19. A plasticizer for plasticizable material comprising an aliphatic monobasic acid ester of an alkyl phenylethyl alcohol.

POLYAMIDE. R. W. Moncrieff and E. W. Wheatley (to Celanese Corp. of America). U.S. 2,378,494, June 19. A fiber-forming condensation polyamide is homogeneously stabilized by heat-reacting with boric acid or a salt or ester thereof.

POLYMER. M. M. Brubaker (to E. I. du Pont de Nemours and Co., Inc.). U.S. 2,378,535, June 19. A resin is prepared by pyrolyzing a diester of 2-mercaptoethanol to obtain a monomeric ester of vinyl thiol and polymerizing the monomeric ester.

POLYMER. M. M. Brubaker (to E. I. du Pont de Nemours and Co., Inc.). U.S. 2,378,536, June 19. The polymer from hydrolysis of a polyvinyl thiol ester.

ELASTOMER. J. Kamlet (to Miles Laboratories, Inc.). U.S. 2,378,559, June 19. An elastomeric polymer is prepared by heating an aqueous polysulfide solution in the presence of an acyl ester of vinyl alcohol.

POLYCONDENSATE. O. Moldenhauer and H. Bock (to Alien Property Custodian). U.S. 2,378,571, June 19. A poly-condensation product is prepared by heating hydrazine dicarboxylic diamide and sebacic acid diamide under pressure, cooling, removing ammonia vapor and finally heating in a vacuum.

RESIN. A. J. Norton (to Monsanto Chemical Co.). U.S. 2,378,575, June 19. A friction element containing a binder comprising a heat reacted mixture of a fusible, reactive, castor oil-modified glycerol phthalate resin and a fusible resin prepared by heating phenol, aniline and formaldehyde.

NITROCELLULOSE. D. R. Swan and J. M. Calhoun (to Eastman Kodak Co.). U.S. 2,378,594, June 19. Nitrocellulose is stabilized by an oxamic hydrazide, gamma phenoxy butyric hydrazide, cyanacetic hydrazide, palmitic hydrazide, semicarbazide, gluconic hydrazide, diphenyl semicarbazide, nicotinic hydrazide, citric trihydrazide or acetone tricarballylic hydrazone.

STABILIZER. T. S. Carswell (to Monsanto Chemical Co.). U.S. 2,378,619, June 19. Polyvinyl acetal resins are stabilized with a saturated quaternary ammonium hydroxide.

COPOLYMERS. W. E. Hanford (to E. I. du Pont de Nemours and Co., Inc.). U.S. 2,378,629, June 19. An alkali-soluble polymer comprising the interpolymer of maleic anhydride and ethylene is prepared by polymerizing in the presence of a peroxide catalyst.

# BOOKS AND BOOKLETS

**Write directly to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent post-paid at the publishers' advertised prices.**

### A Course in the Fundamentals of Electricity

**by Morton Mott-Smith, Ph.D.**

**Published by Westinghouse Electric Mfg. Co., Pittsburgh, Pa., in cooperation with Science Service, Inc., for use in schools as a public service, 1943**

**Price, 15 cents** **65 pages**

Intended for use in high school classrooms, this flexible paper-covered book is written in simple language and is furnished with easy-to-understand diagrams and photographs. The course is based on an official outline prepared by the U. S. War Department for use in pre-induction training courses and was prepared under the direction of engineers of Westinghouse Electric & Mfg. Company. Such subjects as magnetism, static electricity, condensers, induced currents, electric generators, transformers, induction coils, telephones, current rectifiers are taken up.

★ PROPERTIES OF AMERIPOL D are outlined in some detail in a new catalog edition prepared by B. F. Goodrich Co., Akron, Ohio. Property relations of natural and various types of synthetic rubber are given as well as a list of the properties of typical commercially available Ameripol D compounds.

★ TWENTY-FIVE YEARS OF PROGress are observed by Diemolding Corp., Canastota, N. Y., in its anniversary catalog which gives a brief history of the company accompanied by group photographs of the employees.

★ AN 8-PAGE PAMPHLET FROM Behr-Manning, Troy, N. Y., presents complete engineering and production data on methods for speeding up grinding and finishing operations by conversion from abrasive set-up wheels to coated abrasive belts.

★ "CUSTOM MOLDERS TO INDUSTry" shows the wide scope of the molding problems handled by Mack Molding Co., Inc., Wayne, N. J., at its various plants. Photographs, which present products which the company molds, show varied applications in many fields including cosmetics, electronics, aviation and marine.

★ CARBIDE AND CARBON CHEMIcals Corp., New York 17, N. Y., has published a booklet on ethyl silicate which discusses its hydrolysis and use as a source of silica. Applications of the chemical which are described are its use as a bonding agent in the preparation of molds for metal castings, in cellulose nitrate and vinyl resin lacquer formulations to improve adhesion to glass, in the formulation of heat-resistant paint and others.

★ "MOLDING WITH LUMARITH," a new booklet just released by Celanese Plastics Corp., New York 16, N. Y., is an attractive and comprehensive handbook on the injection and extrusion molding processes by which cellulosic thermoplastics are converted into finished parts. Designed to help the layman is a glossary near the front of the book which defines names in the trade.

The book announces an important change in the classification of Lumarith molding compounds whereby the formula number which formerly served to identify each compound is replaced by a new designation which is descriptive of the most important characteristics of the composition. At present the Lumarith ethyl cellulose compounds are not included in this new method of classification.

Each molding compound is taken up separately in a section which includes numerous photographs of possible applications and a complete table of properties of the plastic. Included in the book are tests by A.S.T.M. methods shown in graphs, sketches and text for the various compounds. Cementing, machining and finishing methods are also covered. An appendix gives general reference tables.

★ USERS OF ADHESIVES, SEALERS, coating or insulating compounds, impregnators and sound-deadeners will be interested in a 12-page booklet on "3-M Adhesives in Industry," which has been released by Adhesive and Coatings Div., Minnesota Mining & Mfg. Co., St. Paul 6, Minn. Adhesive operations in many different industries, methods of application and a listing of the physical properties are described and illustrated.

★ THE ORGANIC CHEMICALS AND plastics industries in Pan American countries are discussed in four bulletins from the Industrial Reference Service published by the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce. Number 15 is entitled "Uruguayan Organic Chemical Market;" Number 20, "Synthetic Organic Chemicals in Brazil;" Number 22, "Mexico as a Producer and Consumer of Plastics;" and Number 25, "Cuban Market for Plastics." All are under date of June 1945 and may be purchased from the Superintendent of Documents, U. S. Govt. Printing Office, Washington 25, D. C., or any of the Department's Field Offices.

★ A BULLETIN FROM U. S. STONEware Co., Akron, Ohio, describes the manufacture and fabrication of its corrosion-resistant materials which include plastics, ceramics, metals, natural and synthetic rubber. The booklet also gives specifications, properties and applications.

★ AVAILABLE SOON TO MEMBERS of SPI will be a manual on OPA plastics pricing under MPR-523 by S. Sidney Ullman, formerly in charge of OPA regulations governing plastics and now engaged as a consultant on OPA pricing problems. An account of the historical background of the regulation, an outline of the products affected and the various pricing methods are to be covered.

★ CINCINNATI ELECTRICAL TOOL Co., Cincinnati, Ohio, has released a catalog of electric drills, grinders, buffers and portable tools. Both alternating and direct current specifications are given for most of the tools.

★ THE CONE-LOK JIG IS FULLY described in a booklet received from N. A. Woodworth Co., Detroit 20, Mich. Blueprints, photographs and diagrams supplement the text.

★ MILFORD RIVET AND MACHINE Co., Milford, Conn., has prepared a catalog covering Phillips recessed head machine and sheet metal screws, standard slotted head machine screws, drive screws (Type "U"), screw weights and special cold headed products.

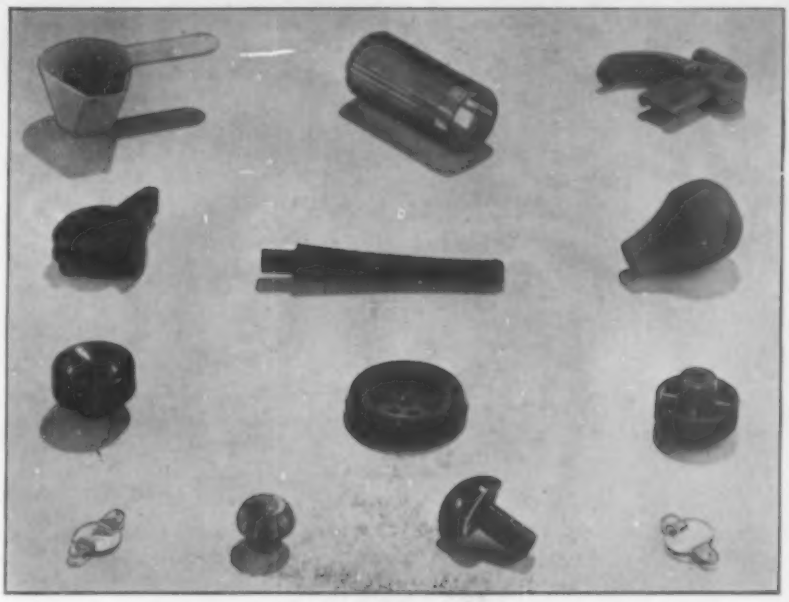
★ A CATALOG FROM HOGGSON & Pettis Mfg. Co., New Haven 7, Conn., presents a line of marking dies, stamps and rolls; cementing and vulcanizing tools; thickness gages; molds and dies for rubber and plastics; and laboratory equipment.

★ REPORT NO. 1 ON DUTREX 20 and 25, plasticizers for vinyl chloride resins, has been received from Shell Oil Co., Inc., New York 20, N. Y. This is a technical bulletin describing the two plasticizers and giving written data and graphs showing their properties.

★ A LOOSE-LEAF BOOKLET FROM Waterbury Companies, Inc, Waterbury 90, Conn., catalogs flat flange eyelets rolled flange eyelets, special eyelets, ferrules and terminals. A number of the items in the book are used as inserts for plastic moldings.

# Injection MOLDING

NUMBER TEN OF A SERIES



Injection molding has in recent years achieved full recognition as one of the basic methods of modern high-speed production, ranking with such high volume processes as stamping and die casting.

As injection molding materials become cheaper and new materials capable of service at both higher and lower temperatures become available, injection molding is being used more and more in place of the older and much slower compression molding process.

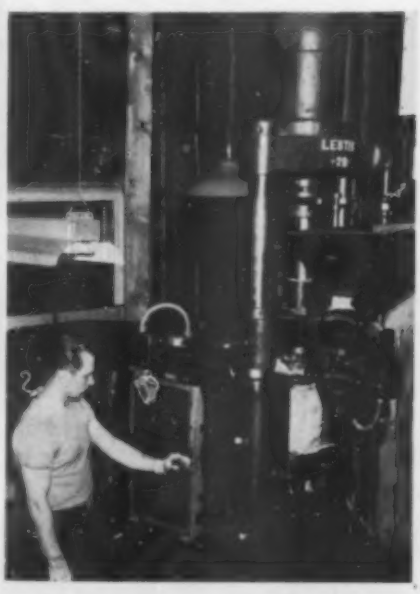
However, millions of plastic moldings are still best made by the compression method, and most compression molders don't like to be bothered with injection machines.

At the Joseph Stokes Rubber Company of Trenton, N. J., however, this is not the case. The Stokes compression molding plant has a single injection machine, a 6-ounce Lester, for molding small parts of thermoplastic material, as an accommodation to their regular customers.

With no record of past experience in injection molding, they installed the Lester machine shown here and have produced, with no particular trouble, millions of injection molded parts. The illustration above shows a representative selection of such parts. The pipe stem shown in the center for example, is made in a 16-cavity mold, on a 45-second cycle.

C. C. Davis, manager of the Stokes molding division, states:

"We have been operating the Lester steadily for almost three years, and it has helped us to give our customers additional molding service without adding materially to our production or maintenance problems. During this period we have never yet flashed a mold. We find the Lester very easy to set up for production because of its simple mold adjustment (with a single hand crank) and the accessibility of the mold space."



Perhaps the Stokes story will give *you* an idea. But whether you need one Lester or 20 Lesters, you'll find the production and maintenance story the same: the largest possible production of the finest molded parts with the lowest possible operating and maintenance cost.

Lesters are made in six capacities, for 4, 6, 8, 12, 16, 22, 24 and 32-ounce moldings—with larger models to come. Write today for details.

## Injection Mold Design

Islyn Thomas, New York plastics consultant, has written two clear and authoritative articles on the subject of injection mold design, planned to bring together the plastics customer, the sales engineer and the mold designer so that they may reach a better understanding of one another's problems. As a service to the industry we have reprinted these and offer them free to the readers of this magazine. Send for your copy today.

**INJECTION MOLDING MACHINES**

*"Shaping the Things of Tomorrow"*

*National Distributors:*

**LESTER-PHOENIX, INC., 2711 Church Ave., Cleveland 13, Ohio**

# SAV-WAY ANNOUNCES

# the *Pacemaker*

# 1 to 2 Ounce Injection Molding Machine Designed for Experimental, Educational and Production Use

THE Sav-Way Pacemaker is a precise and efficient laboratory press, ideally suited to plastics research, development, and instruction. The perfect press for making small scale pressing tests, preparation of samples, testing single cavity molds, and for small scale production.

**★ EXPERIMENTAL** — An important advantage of the Pacemaker is the small amount of material required for the pressing operation and the elimination of waste. Operation is under constant control by easy-to-reach control handle.

**★ EDUCATIONAL** — As a press for use in plastics instruction, the Pacemaker is ideal as it provides all of the primary principles of injection molding on a small scale.

**★ PRODUCTION** — As a production press for small pieces, the Pacemaker offers many advantages, among them cheap mold construction, simplicity, and ease of cleaning. The injection nozzle and spreader are constructed as one unit, easily removed with automatic stop-off at the nozzle.

## PACEMAKER SPECIFICATIONS

| | | | |
|---|---|---|---|
| Capacity | 20 tons | Heating elements | 1,000 watts |
| Maximum stroke | 11½" | Floor space | 29 x 30" |
| Lower platen | 10 x 10" | Height | 6½ feet |
| Mold casting area | 4 square inches | Gross weight | 1200 lbs. |
| Current | 220 volt, 3 phase | Line pressure | 0 to 2,000 (P.S.I.) |

Independent switches for heating elements and hydraulic system.
Large capacity hopper with convenient manual quantity control.

## STANDARD EQUIPMENT

| | |
|---|---|
| Electronic temperature control | (0 to 500° Fahrenheit) |
| Pressure gage | 0 to 3,000 pounds |
| Motor | 3 H.P. |

## SPECIAL EQUIPMENT

Indicating pyrometer, controlling heat to plus or minus 1° Fahrenheit.

**WRITE FOR COMPLETE TECHNICAL INFORMATION AND PRICES**

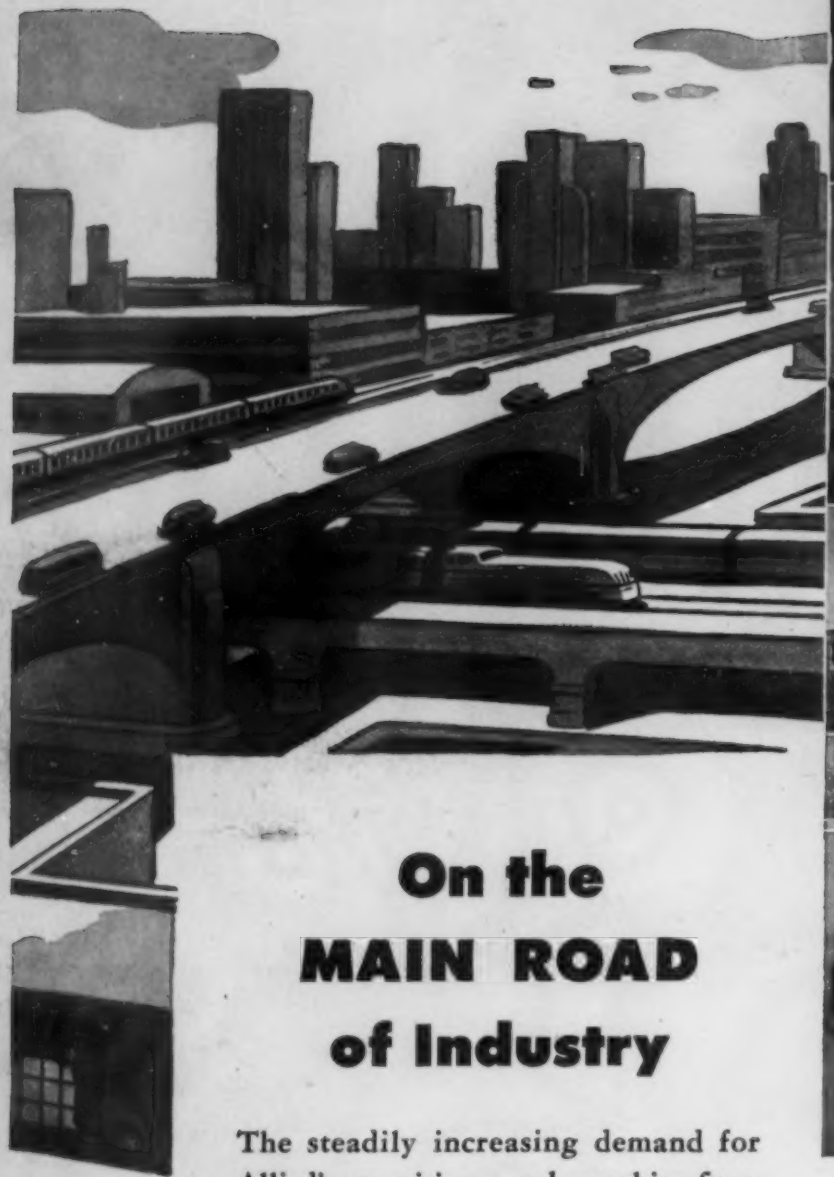
Sav-Way

# SAV-WAY INDUSTRIES

**P. O. Box 117, Harper Station . . . Detroit 13, Michigan**

***International sales and service representatives throughout the world***

*The*
*Saw-Way Pacemaker*



# On the MAIN ROAD of Industry

The steadily increasing demand for Allied's precision workmanship from the very beginning has fostered the enlargement of its working area from 5000 square feet in one plant in 1915, to 275,000 square feet in four great plants today. This growth over a period of 30 years . . . steady and consistent . . . places Allied solidly on the main road of industry . . . establishes Allied as a standard source of precision tools and parts *in great quantity* for automotive, radio, home appliance, plastics, aviation, furniture, electrical, farm implement and many other mass production manufacturers. Send in *your* blueprints . . . or write to Allied, now.

BUY WAR BONDS

★ ★ ★

***"IT'S AN ALLIED PRODUCT."*** In its four plants shown above—two in Detroit and two in Hillsdale, Michigan—Allied makes special cold forged parts, cap screws, etc.; hardened and precision ground parts; sheet metal dies (from the largest to the smallest); R-B Interchangeable Punches and Dies; jigs, fixtures, steam-heated plastic molds and special production tools.

## ALLIED PRODUCTS CORPORATION

Department 26
4622 Lawton Avenue
Detroit 8, Michigan

# In Aluminum, they weigh only 1/3

You counted on saving weight when you decided to use a plastic. Then why use heavy metal inserts? Aluminum weighs only one-third as much, piece for piece, so it enables you to save weight there, too.

Three times as many pieces per pound often means a considerable dollar saving on these inserts.

The light color of aluminum is frequently very desirable from an appearance standpoint. Inserts in transparent plastic are less conspicuous when they're made of aluminum. Metal surfaces to be exposed can be given many attractive finishes, including colors, adding greatly to the appearance of the parts.

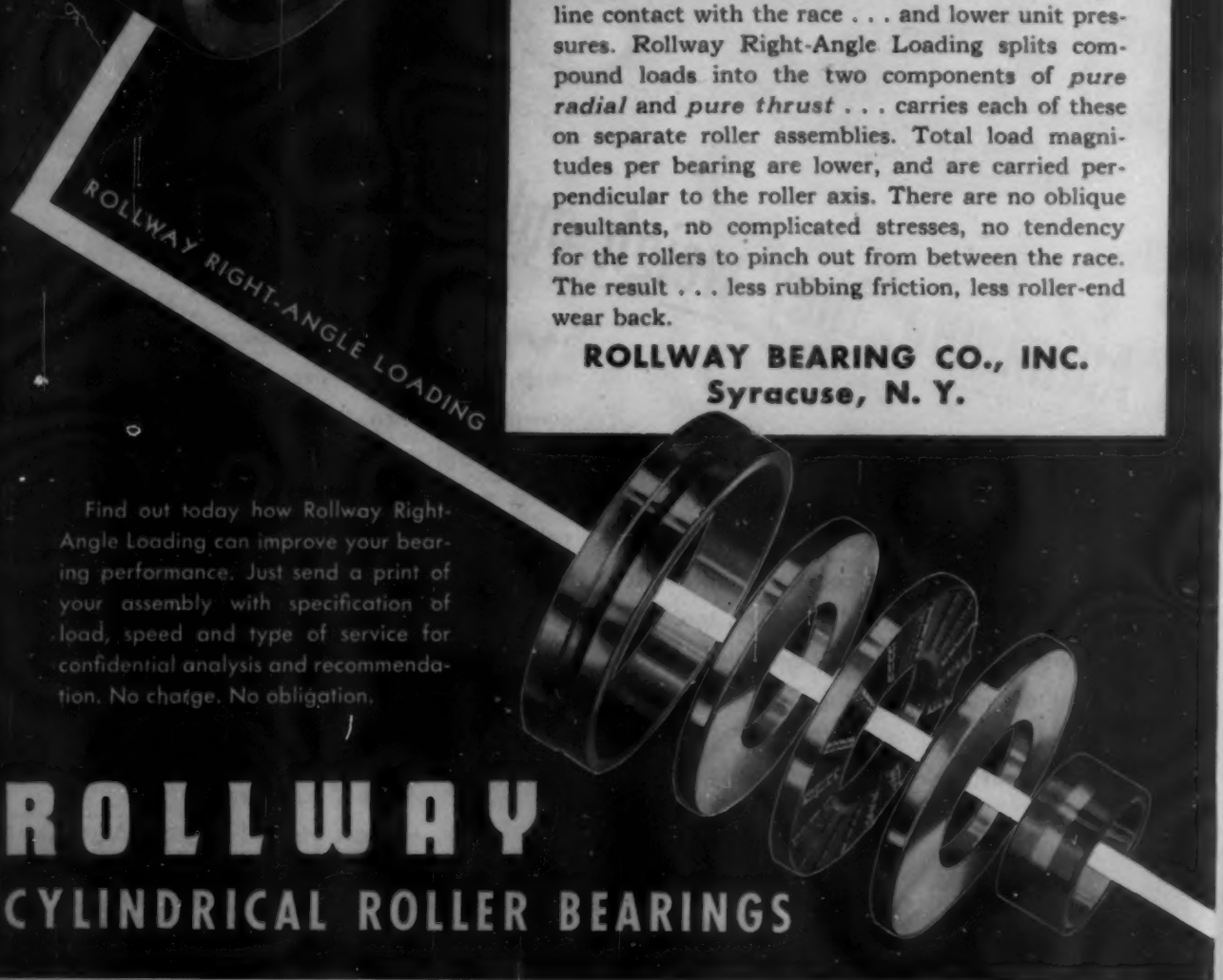
Alcoa will gladly quote on your aluminum inserts, or on the Alcoa Aluminum stock for fabricating them in your own plant. ALUMINUM COMPANY OF AMERICA, 2175 Gulf Building, Pittsburgh 19, Pennsylvania.

**ALCOA** FIRST IN **ALUMINUM**

ALCOA ALUMINUM

# BEARING CAPACITY

## *for tomorrow's heavier machine loads...*




### Change to Rollway Right Angle Loading

In the drive for postwar production . . . for competitive advantage in postwar markets . . . machines will be pushed to new limits. Bearings which served reasonably well under war conditions will now lack the freedom from service attention, the life expectancy, the load capacity required for satisfactory operations on new peacetime output.

That's when it will pay to change to Rollway Solid-Cylindrical Roller Bearings. Bearings that give you more metal to carry the load . . . longer line contact with the race . . . and lower unit pressures. Rollway Right-Angle Loading splits compound loads into the two components of *pure radial* and *pure thrust* . . . carries each of these on separate roller assemblies. Total load magnitudes per bearing are lower, and are carried perpendicular to the roller axis. There are no oblique resultants, no complicated stresses, no tendency for the rollers to pinch out from between the race. The result . . . less rubbing friction, less roller-end wear back.

**ROLLWAY BEARING CO., INC.**
**Syracuse, N. Y.**

Find out today how Rollway Right-Angle Loading can improve your bearing performance. Just send a print of your assembly with specification of load, speed and type of service for confidential analysis and recommendation. No charge. No obligation.

# ROLLWAY
## CYLINDRICAL ROLLER BEARINGS

SALES OFFICES: Philadelphia • Boston • Pittsburgh • Youngstown • Cleveland • Detroit • Chicago • St. Paul • Houston • Tulsa • Los Angeles

*Quality* is the perfect recommendation

GMP

*Molders of Plastics*

SOCIETY OF THE PLASTICS INDUSTRY · SPI

GENERAL MOLDED PRODUCTS · INC

OFFICE AND PLANT · DES PLAINES · ILLINOIS · *Suburb of Chicago*

From Each Pound Output up 95%

DESIGN - the MPM staff includes creative engineers experienced in industrial design

MOLD MAKING - completely equipped facilities for precision work

PLASTICS MOLDING - skilled operators, power presses for compression and transfer molding

## YOU CAN PROFIT BY THIS DEMONSTRATED ABILITY

Make use of the proved resources of Minneapolis Plastic Molders to lower costs . . . to increase production . . . to find a better way to do the job. MPM facilities bring you the benefit of the knowledge of specialists, each experienced in his own line, for industrial design, mold and die-making, compression and transfer molding. Responsibility for handling all phases of the work is centered at one single source.

### IF YOU HAVEN'T USED PLASTICS

There is nothing about plastics in themselves. But it is amazing how often plastics can be used to cut costs, to step up quality and performance—factors that lead directly to important sales advantages.

Write for recommendations about how your molding problems can best be met — for suggestions about new uses for plastics in your business. No obligation.

INSPECTION - the final step. Every operation, from design to finished product, handled by MPM. Photo shows frangible bullet inspection

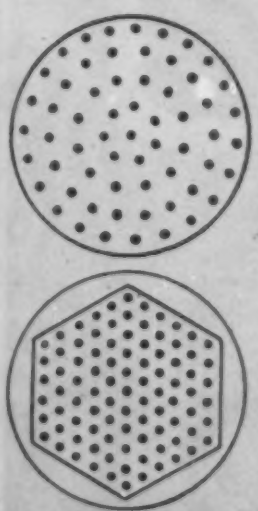
# -Waste cut 37%

## 45 Units Instead of 23 from Every Pound of Molding Compound

### THE FRANGIBLE BULLET

. . . . was developed by the Army Air Forces and the National Defense Research Council for gunnery training. The bullets are used for actual combat practice and disintegrate when they strike the specially treated armor plate used on the training planes.

### A SIMPLE CHANGE WITH ASTONISHING RESULTS!



Shown at left is a diagram of the mold originally adopted. The lower diagram is the MPM concentrated pattern in mold design. Waste space cut to a minimum . . . production increased . . . materials saved.

## . . . THE AMAZING RECORD ESTABLISHED BY MINNEAPOLIS PLASTIC MOLDERS IN FRANGIBLE BULLET PRODUCTION . . .

When large scale production of frangible bullets commenced, original mold designs turned out 23 bullets from every pound of molding mixture. Over two thirds of the compound was left in the cull.

Convinced that much of this waste could be turned to increasing output of the urgently needed bullets, MPM designers took up the problem of improving the mold design. They found the answer — *emphatically* — in the ingenious hexagonal mold. Forty-five bullets, are now turned out in place of twenty-three. A gain of 95%! Savings in materials total approximately $370,000 monthly.

The hexagonal mold represented a departure from established concepts. The cavities, for example, are ground internally instead of hobbed. There were some who declared the whole plan impractical. But MPM is organized to develop new methods. Complete mold making facilities equipped for precision work are combined with imaginative designers and practical molding experience. Responsibility for every assignment remains at one source. Minneapolis Plastic Molders contribution to the frangible bullet program is evidence of ability to deliver.

MPM

## MINNEAPOLIS PLASTIC MOLDERS, Inc.

2300 EAST 31st STREET — MINNEAPOLIS 6, MINNESOTA

# WHY TRANSFER MOLDING GIVES LONGER RUNS

**Longer production runs of more accurate parts are possible by using Transfer molding instead of compression molding.**

**In compression molding, it is often necessary to place the charge carefully in the mold cavity, making sure that each area has its proper volume of compound. Slow closing and breathing are also used, to insure full density of the part. Finely finished mold sections are subjected to abuse and strains when the charge is thus loaded and plasticized in the cavity.**

**In Transfer molding, as in the case of the telephone handset shown at right, the charge is loaded in the transfer chamber and plasticized there, then forced into the already closed mold in its fluid state. After the compound has thermoset, the mold is opened and the molded part is removed.**

**The possibilities of errors or mold damage are minimized, because the operator merely cleans the mold, drops the charge in the transfer chamber and operates a valve to close the mold. Transfer molding thus lengthens mold life and produces parts of greater accuracy. For more information, please write for the literature listed.**

SHAW

**SHAW INSULATOR COMPANY**

160 COIT STREET — QUALITY MARK ON MOLDED PLASTICS — IRVINGTON 11, N. J.

*LITERATURE IS AVAILABLE AS FOLLOWS:*

A list of nearby licensees who can offer you the advantages of the patented Transfer molding process.

Two bulletins on "Why Transfer Molding is Economical". Bulletins on "Why Transfer Molding Gives Fine Inserts", "Why Transfer Molding Improves Appearance", "Why Transfer Molding Permits Better Holes", "Why Transfer Molding Permits Variable Walls", and "Why Transfer Molding Gives Uniform Strength".

Unbiased counsel in plastics applications is available from Shaw and Plax Corporation, Hartford 5, Conn. Between them, these companies use nearly all plastic processes. For names of nearby licensed Transfer molders and for literature listed above . . . write Shaw.

# NEW SPECIAL PLASTIC SHAPES BY PLAX

Molding and continuous extruding by Plax, of special shapes in hitherto impossible sizes, open up a whole new realm of plastics applications.

While these applications have been restricted to wartime necessities, and for the most part may not be revealed, the mere indication of the shapes and sizes themselves will excite engineering minds to the visualization of their full possibilities.

The pieces shown in the photograph at the left range from a two-inch-thick slab of polystyrene to a six-inch-diameter cylinder and a four-and-one-half-inch diameter tubing with three-eighths-inch walls. These, the fluted tubing, the piece with varying cross-section, and many other special shapes can be produced in all colors, from crystal clear through jet black, in polystyrene and other thermoplastic materials.

Subsequent machining, with which Plax is thoroughly familiar, can produce unusual structural combinations with superior insulating and other desirable characteristics common to polystyrene and other plastics.

*LITERATURE IS AVAILABLE AS FOLLOWS:*

Several bulletins on Plax polystyrene products and how to machine them.

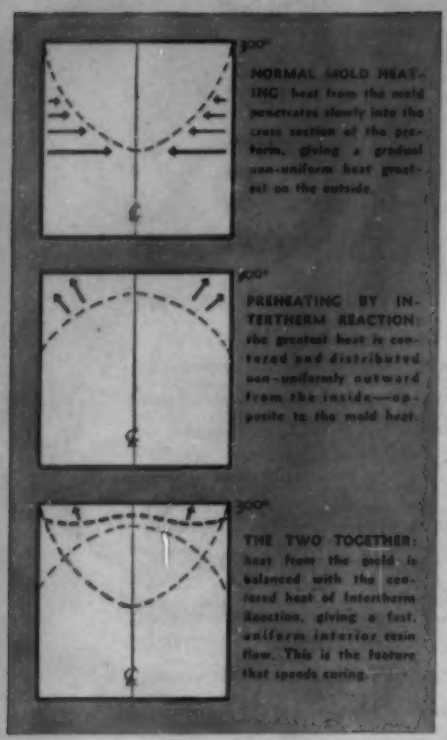
A technical article on Plax blown products.

Bulletins on Plax cellulose acetate, cellulose acetate butyrate, methacrylate, and polyethylene products.

Styramic and ethyl cellulose are among the other materials offered by Plax in various forms. In cooperation with the Shaw Insulator Company, Irvington 11, N. J., Plax can give you help covering nearly all plastic materials and methods. For such help, or for any of the literature listed above . . . write Plax.

PLAX
FOR PLASTICS
NOT SUBSTITUTES···IMPROVEMENTS

133 WALNUT STREET ★ HARTFORD 5, CONNECTICUT


NORMAL MOLD HEATING: heat from the mold penetrates slowly into the cross section of the preform, giving a gradual non-uniform heat greatest on the outside.
PREHEATING BY INTERTHERM REACTION: the greatest heat is centered and distributed non-uniformly outward from the inside—opposite to the mold heat.
THE TWO TOGETHER: heat from the mold is balanced with the centered heat of Intertherm Reaction, giving a fast, uniform interior resin flow. This is the feature that speeds curing.

*"Intertherm Reaction" is diagrammed above. These charts show what happens during the first instants of molding pressure — and clearly demonstrate the advantages of Mann-Russell Preheaters.*

★

*Below: Mann-Russell Electronic Preheater Model 33. Width: 19 inches overall. Depth: 24 inches overall. Height: 63 inches. Work rate of more than 3300 BTUs/hr. Frequency: plus and minus 27.3 mc. Three-minute automatic timer. Capacity: over one pound per minute.*

# MANN-RUSSELL ELECTRONIC PREHEATERS

## *Offer You These Big Advantages*

### 1-FAST, UNIFORM RESIN FLOW!

Because "Intertherm Reaction" places the greatest heat INTERNALLY and NON-UNIFORMLY throughout the preform during preheating, the external mold temperatures and the internal heating are balanced (see chart)—giving fast, uniform flow characteristics even when intricate molds are used. Production is speeded, larger pieces are molded on the same press capacity, flash and rejects are reduced to a minimum.

### 2-LESS SERVICE REQUIRED!

Mann-Russell Preheaters DO NOT REQUIRE expensive and complicated automatic tuning regulators. They are single standing-wave generators with automatic cut-off timers. Power input is kept in proportion to load at all times and no change in electrodes is necessary for preforms of varying sizes. Because automatic tuning is not necessary, operation of the Preheater is greatly simplified; maintenance greatly reduced.

### 3-A SIZE FOR EVERY NEED!

Sturdy, all-metal Mann-Russell shielded Electronic Preheaters are available for fast delivery in sizes and BTU ratings for every molding job. All units feature automatic self-compensating preform ovens, simplicity of control, and compact, portable, upright design. Units available for lease or outright sale. Write Northwest Syndicate, Inc., for complete data and price lists. This company's continuing research is devoted to helping you solve your production problems through the proper application of RF heat generation. Representatives in principle cities.

# MANN-RUSSELL

*high frequency*

## PREHEATING GENERATORS

m and R RF SYSTEM

NORTHWEST SYNDICATE, INC.
711 ST. HELENS AVENUE
TACOMA 1, WASHINGTON

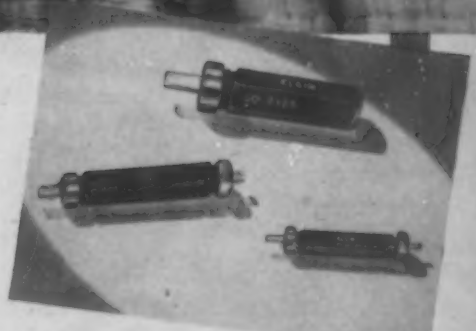
Operated by Geo. F. Russell and Julius W. Mann

SPECIFY

# Sandee HEXAGONAL PLASTIC ROD

## Preferred for an Ever-Increasing Number of Important Industrial Applications

One of the newer users of Sandee Hexagonal Extruded Plastic Rod is Elgin National Watch Co. Their highly accurate Test Plug Gauges, are made with handles of Sandee red translucent Cellulose Acetate Butyrate extruded plastic rod. As in screw driver handles, the hex shape keeps the tool from rolling on a flat surface. This tough non-magnetic material made in standard sizes up to 1 inch, is readily machined . . in this case, drilled and threaded and slotted to receive a split threaded bushing with a locking nut. Hex rod is only one of the many fine extruded plastic products we make. The Sandee catalog, describing our complete service, embracing Rigid and Flexible Plastic Extrusions, is yours for the asking.



SALES REPRESENTATIVES IN 19 PRINCIPAL CITIES

Sandee Manufacturing Company

3048 NORTH WESTERN AVENUE • CHICAGO 18, ILLINOIS

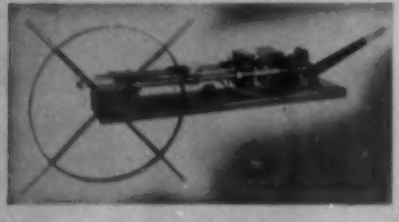
EXTRUDED PLASTICS AND SPECIAL TOOLS

# NEW MACHINERY AND EQUIPMENT

★ A SMALL TESTING MACHINE for plastics, plywood and the lighter sheet metals has been developed and is being produced by Southwark Division of Baldwin Locomotive Works, Philadelphia, Pa. It has an alternating force capacity of 100 lb., a speed of 1800 load cycles per min., and a maximum capacity in bending of

200 in. lb. and in torsion of 1125 in. pounds. An outstanding feature of the machine permits any predetermined alternating load to be kept automatically constant regardless of the changes of deflection which may occur in the specimen.

★ THE MIDGET MOLDER, built by Van Dorn Iron Works Co., Cleveland, Ohio, to inject up to $^3/_4$ oz. of thermoplastic material, offers a low-cost method of testing small molds and single cavities. The machine can also be used for small production runs. It features a toggle mechanism used to open and close the mold quickly and to clamp it rigidly dur-



ing injection, a clear platen area 8 by 8 in., and a 4-in. mold opening over and above the 3- to 7-in. daylight adjustment for different size molds. Heater controls are built in, and the resistance heater itself is completely plated inside and out. The manufacturer reports that the machine's unique design permits the plunger stroke to be adjusted so that different lengths of heaters may be easily installed for experimental purposes.

★ MODIFIED FOR USE WITH VERTICAL set-ups only, the new Model J-10A "Jiffy Jig," product of Monarch Governor Co., Detroit 6, Mich., includes all features of the earlier jig, with the exception of the bracket used in horizontal set-ups. The new model is said to be adaptable to various machine tools for drilling, milling, grinding, boring and other operations. The jig is said to have capacity for stock ranging from $^1/_{16}$ to 1 in. in cross section, and may be used in conjunction with an automatic spring ejector if desired.

★ AN INTERVAL TIMER OFFERED by Paragon Electric Co., Chicago 5, Ill., is said to be designed especially for timing the curing of rubber and plastics. A self-starting motor operates and times the instrument, which is available in 10 time ranges, varying from $^1/_4$ sec. to 20 hours. Easily operated, the timer has a pointer which returns to zero automatically at the end of the present time, lighting a bull's eye signal light or else operating a built-in buzzer.

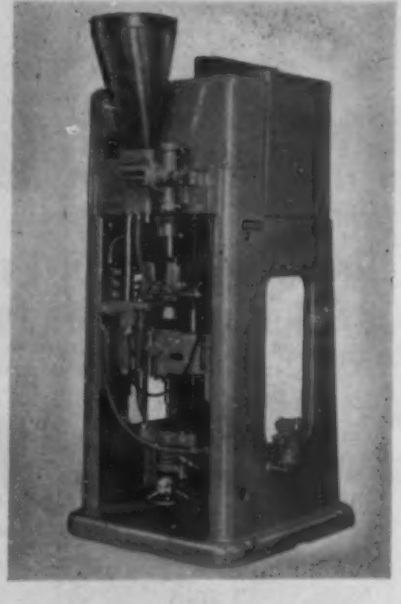
★ TWIN-FAST, A NEW, IMPROVED screw for wood or plastic which is manufactured by the Apco Manufacturing Co., Santa Monica, Calif., employs two balanced threads instead of one. According to the manufacturer, it requires half the driving time of ordinary screws and has 50 percent greater tensile holding power. Its threads are cold forged by a patented lateral extrusion process.

★ AIRCRAFT TOOLS, INC., LOS Angeles, Calif., has manufactured the Drilpilot which permits drilling and countersinking, drilling and spotfacing, or drilling and counterboring in one operation. This tool, made of high speed steel, can easily be changed over from one job to another and put through a wide range of operations.

★ W. H. NICHOLS & SONS, WALtham, Mass., has announced a new line of double spindle milling machines for light production work requiring medium duty cuts in plastics and metals. The units are designed for two cuts to be made simultaneously with resultant savings in set-up and production time. One model has two opposed spindles with No. 40 milling machine taper with adjustments so that they may be lined up or set out of line vertically $2^1/_2$ in., horizontally $2^1/_2$ in., or in or out $1^1/_2$ inches. Another model can be supplied with two identical spindles, one directly over the other, with a vertical adjustment. This arrangement makes it possible for the center line of the spindles to be positioned from $4^1/_2$ in., minimum, to $7^1/_2$ in., maximum. Both models have a choice of spindle drives and are regularly equipped with two motors, one for each spindle, so that it is possible to have an entirely independent selection of spindle rotation.

★ MADCO PRODUCTS, INC., NEW York 18, N. Y., has designed a 6-spindle turret attachment Model No. 275 for drill presses featuring a new type of indexing depth stop which controls the drilling depth of each of the 6 spindles of the turret head. Completely enclosed, the depth stop mechanism comprises a cylindrical drum carrying 6 adjustable stops which can be positioned through an opening in the aluminum alloy housing. The turret head is provided with precision ground spindles which are said to be responsible for increased accuracy, greater interchangeability of tools and the elimination of chucks.

★ A COMPLETELY AUTOMATIC molding machine, Model 200 D, announced by F. J. Stokes Machine Co., Philadelphia 20, Pa., features a new type



trap. This checking device, said to be sensitive to the fraction of a gram, weighs finished moldings and operates a safety cut-off which stops the machine and signals for attention in case a molded piece sticks in the mold or is of insufficient weight. The machine is also equipped with a combination push-off which ejects mechanically if the multiple air-jets do not blow the molding into the trap, and a triple-feed device which can be adjusted to distribute exact quantities of molding powder where desired in the mold. Fifteen tons is the capacity of the machine.

# This New Name
# Vulcanized Rubber and Plastics Company

(formerly The Vulcanized Rubber Company)

means new and improved services for volume users of hard rubber, soft rubber and molded plastic parts and products.

**With the expansion of the Plastic Division, our research, engineering and manufacturing facilities are available to help manufacturers and fabricators overcome their experimental and production problems on plastics as well as hard and soft rubber—from selection of the proper material to precise quality control that assures uniform adherence to specifications.**

**Which is the best material for your part or product?**

*PLASTICS?*
*HARD RUBBER?*
*SOFT RUBBER?*
*WHAT COMPOUND?*

The chemical and physical properties of a material affect a product from design to actual performance. New plastics are constantly emerging. The properties of plastics such as Cellulose Acetates, Acrylics, Phenolics, Polystyrene and Vinyls, for instance, differ a great deal. Research on rubber is continuing and new synthetic rubber formulas are being developed. When natural rubber returns, we will have a greater range of compounds.

The material that is best for your part or product depends on the job it has to do.

**Plastics? Fine. But are you sure Hard or Soft Rubber won't do it better?**

Just as it made sense for us, with our molding experience, to go into the new plastics, it also made sense to continue our research and fabricating on the older plastics . . . hard and soft rubber. In many applications they work far better than any of the newer plastics, particularly where dimensional stability in the presence of heat, moisture and solvents is a requirement.

A certain type of plastic, or formula of hard or soft rubber; a metal or a combination may be the best answer.

**It might pay us both to get together.**

We have the chemical and physical research and testing laboratories to help you find the right material. And we have a wealth of experience in fabricating molded forms.

Starting over sixty years ago with hard rubber, one of the first plastics, we have constantly sought to convert any new development in plastics to the mutual benefit of our customers and ourselves. If yours is a volume product or part, chances are that our research assistance and facilities for efficient, large-scale production will fill your needs at reasonable cost.

Just tell us where and how your part or product has to go to work, or give us the specifications. If we should find that the part or product doesn't belong, economically or physically, in any one of the wide range of plastics, hard rubber, soft rubber, or molding methods that we are set up to handle, we will frankly say so and recommend what we think is best.

**CHEMICAL RESEARCH AND TESTING. QUALITY CONTROL.**

This modern laboratory with complete equipment is at the disposal of our trained staff to help you select the right material and control the quality of your part or product by testing for adherence to specifications in the various phases of production.

**PHYSICAL TESTING AND QUALITY CONTROL.**

A completely equipped physical testing laboratory checks your product from design to performance requirements. Machinability, tolerances, hardness, dimensional stability and other physical properties are checked for adherence to specifications.

**VULCANIZED RUBBER AND PLASTICS COMPANY**

formerly . . . The Vulcanized Rubber Company

Manufacturers of Rubber and Molders of Plastics

General Offices: 261 Fifth Avenue, New York 16, New York. Works: Morrisville, Penna.

# WASHINGTON ROUND-UP

R. L. VAN BOSKIRK, Washington Editor

# Plastics Branch retires

THE Plastics Branch of the Chemicals Bureau of the War Production Board has become virtually a historical body. As a part of that history it is fitting that printed acknowledgment should be made of the services performed for Government and industry by all those men and women who were such a vital part of its organization during the four long war years.

The key personnel who served in the Plastics Branch were an understanding group who realized the problems of their industry. By and large, they knew how to say "No" without baring their teeth. It was not unusual for one of them to become angry when he felt that some supplicant was attempting to evade the regulations purposely, but there was seldom cause to brand any of them as a "Bureaucrat" with its spiteful connotations. They were loyal to their own industry but quick to challenge any suspicion that their first loyalty was due to any personality or group other than the U. S. Government and the war effort.

Their accomplishments are the more remarkable to old-time Washingtonians because they moved in on hide-bound Government routine and its unbreakable traditions without any conception of what those traditions implied. They were frequently forced to deal with affairs quite foreign to their previous business experience. Until one has faced a situation of this type, it is extremely difficult to realize the problems involved.

Plastics Branch officials were conscious of many difficulties imposed upon the industry—of how their decisions sometimes resulted in scrambling producer-customer relations with resultant loss of long-time customers in many cases. But they generally managed to make such decisions stick by using velvet gloves without the iron fists. They undoubtedly make mistakes, but unlike typical bureaucratic administration, they were mistakes of action rather than inaction. It was not unusual to hear an administrator say, "We'll try it now.—If it doesn't work, we'll change it quickly." Sometimes the "quick changes" caught industry by surprise but it was seldom that anyone could complain that "nothing constructive was being done."

Critics might point to the acetate molding powder situation as a possible example of the "hesitation waltz" when there was considerable doubt as to the best way of handling allocations, but that was a peculiar situation including a multitude of problems, many of them generated within the industry itself.

There were also times when it looked as though certain operators were receiving preferential treatment. Perhaps they were, but in war time there is no equality and some individuals have an innate capacity for using their elbows to crowd in. When such occurrences happened they were generally outside the control of Plastics Branch officials who were just as wrathful as anyone else, but dutifully held their tongues.

Then there was another task performed by Plastics Branch officials which was never publicized and of which there is no record. It was all done vocally. That was the business of working with other WPB branches to help the plastics industry obtain supplies necessary to carry on their operations. Fabric for laminators and flock for filler were examples of this responsibility.

Plastics Branch officials were always on the alert to see that the needs of their industry were considered when orders affecting supply materials were being prepared anywhere in the War Production Board. If they ever failed of achievement, it wasn't for lack of effort.

The Chemicals Bureau, of which the Plastics Branch was a part, also deserves an accolade. Their operations were on a much larger, over-all scale. They faced powerful competition from other government agencies in obtaining supplies and facilities for their industry. There have been accusations that more aggressive leadership could have won more concessions that would have strengthened the industry, but the Chemicals Bureau operated on the theory that its only mandate was to provide the required chemicals for the war effort.

In that task they seldom failed. Officials would be the last ones to deny that mistakes had been made, but their frankness in admitting them and quick moves to correct errors were freshing. Furthermore, it wasn't necessary to obtain a clearance from the FBI, a birth certificate and a declaration of upright character from the local parson to get in to see them. Their doors were always open to "visiting firemen," many of whom went in spitting venom like a flame-throwing tank and came out like a man with a bride. By and large, the plastics industry can be grateful that its administrative chores were under the aegis of the Chemicals Bureau of the War Production Board.

And again for the record, credit should be accorded the two Armed Forces liaison men who sat in with the Plastics Branch to look after the needs of the Army and Navy, respectively—namely, Major L. E. Humphrey and Lieutenant Ralph R. Browning, Jr. Both were reserve officers who may well have preferred other berths but were chosen by their respective commands as officers especially fitted to help channel plastics into useful Army and Navy items. They didn't make headlines, and many operators in the industry never heard of them—didn't even know that such jobs existed. They were frequently caught in the middle between their Service Force requisitioners who wanted "everything for anything" and Plastics Branch officials who were striving to determine which and what were the most important items. Their duties were onerous—their responsibilities grave—their achievements worth more than passing acclaim.

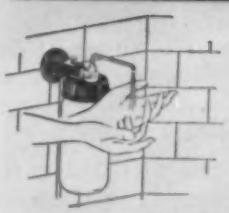
The plastics industry, as a whole, is proud of its part in the war effort. A good part of that pride can be credited to its representatives in WPB who, despite irritating circumstances and governmental routine, maintained amiable relations with the industry while putting through a hard-boiled program that is entitled to highest praise from the Armed Forces.

# KILLING CORROSIVE CONTAMINATION . .

## *and cutting costs*

WITH

MOLDED PLASTICS



VESTAL Chemical Laboratories, Inc., of St. Louis, accomplished three things when they replaced the metal base and head of their Septisol soap dispenser with a molded plastic unit. First, they prevented corrosion and the accumulation of verdigris on the metal head, thus eliminating the danger of contamination as well as the necessity of frequent cleaning and polishing. Second, they materially reduced the cost of the dispenser. And, third, they produced a much handsomer unit that will retain its sleek, sparkling finish indefinitely.

The job of redesigning the dispenser head was worked out in close collaboration with CMPC Development Engineers. Because of the complexity of the part, a rather unusual split-cavity mold was required, having seven removable plugs. This, too, was designed and built by CMPC. The material used was a special phenol formaldehyde whose chief characteristics are medium high impact, high flexural strength, and the ability to retain a smooth surface in contact with water and mild alkali. Thus, every requirement for strength and permanent beauty was met.

There's nothing particularly complicated about this job. It's just one of many thousand plastics molding jobs we've handled. But it offers a typical example of CMPC cooperation . . . of our ability to study, analyze, and solve a difficult molding problem to the complete satisfaction of the customer. It explains why CMPC has won a nationwide reputation for quality and service. And it's a mighty good reason for asking for the services of a CMPC Development Engineer when you're ready to discuss your molded plastics needs.

**CHICAGO MOLDED PRODUCTS CORPORATION**

**1046 N. Kolmar Ave. Chicago 51, Illinois**

*Branch offices in principal industrial centers*

COMPRESSION AND INJECTION MOLDING OF ALL PLASTIC MATERIALS

# NEWS OF THE INDUSTRY

HIRAM McCANN

VAL WRIGHT

★ TWO MEMBERS HAVE BEEN added to the editorial staff of MODERN PLASTICS magazine: Hiram McCann as Eastern Editor and Val Wright as Midwestern Editor.

Mr. McCann, who has served this magazine as Canadian correspondent since 1943, has been active in Canadian publishing fields for the past sixteen years. From 1941 to 1943, when he was borrowed by the Canadian government to handle special wartime educational assignments and public relations for the Canadian National War Finance Committee, he acted as managing editor for the Industrial Magazines Div., Consolidated Press, Ltd. Mr. McCann was graduated from McMaster University.

Mr. Wright, who will act as Midwestern Editor for both MODERN PLASTICS and MODERN PACKAGING, was graduated from the School of Journalism, University of Missouri. From 1938 until he joined our publications, he was on the editorial staff of National Provisioner, becoming managing editor in 1942.

★ COMPLETE ENGINEERING SERvices in the application of electronics to industrial uses are now offered in the branch laboratory which Raymond M. Wilmotte, director of Wilmotte Laboratory, Inc., Washington, D. C., has recently opened at 236 W. 55th St., New York 19, N. Y. The New York laboratory will be under the supervision of Paul H. Crego.

★ EDWARD SCHMIDT AND A. J. Palme have resigned from Shaw Insulator Co. to manufacture molds for the plastics industry. Their new plant, operating as Fidelity Tool Co., is at 21 S. Essex Ave., Orange, N. J.

★ SELF-STERILIZING FOOD WRAPpers are a new application of the alkyd automotive finish resin, Duraplex C-49, according to an announcement by Resinous Products & Chemical Co., Inc., Philadelphia, Pa. The new S-Coatings, originated at the California Institute of Technology by the staff of the Rare Metals Institute under the direction of Dr. Alexander Goetz, are presently being manufactured on a commercial scale as a "Sterilite" product by Shellmar Products Co., Mt. Vernon, Ohio. Based upon the germicidal action of silver, the development points to possible future use of the coatings on the edge of drinking glasses, on wrappings for bandages or on the bandages themselves, as well as on bacteria-destroying wrappers for many perishable foods.

★ AN EVENING COURSE ON NEW synthetic textile fibers, yarns and materials will be offered by Columbia University, Extension Division, New York 27, N. Y., starting October first. The 15 lecture course, to be under the direction of Herbert R. Mauersberger, textile consultant, and technical editor of Rayon Textile Monthly, will cover all new manmade fibers, yarns and fabrics other than rayon, namely: nylon, Vinyon, Aralac, Velon, Saran, glass, soybean fiber, peanut fiber and plastic-coated yarns.

★ A PLASTIC COATING MATERIAL said to be waterproof, fungus resistant and non-inflammable has been developed by Eronel Industries, Los Angeles 35, Calif. Known as Eronel Firefoil, the coating can be easily applied to fabrics by dipping or spraying methods, or with roller-coaters, spreaders or brushes.

★ NILS ANDERSON, JR. HAS BEEN appointed vice president of Casein Co. of America, division of Borden Co., New York 17, N. Y.

★ A TREND TOWARD EXPANSION of chemical manufacturing facilities on the West Coast is seen in the news that through its Seattle subsidiary, I. F. Laucks, Inc., the Monsanto Chemical Co., St. Louis 4, Mo., has purchased about 29 acres of land south of the Seattle city limits. Upon this site the company plans to erect a completely modern plywood adhesives plant for the production of synthetic resins for adhesives, coatings and wood preservatives. Here Laucks operations now carried on in two present Seattle plants will be combined.

★ DOW CHEMICAL CO., MIDLAND, Mich., has announced an improved polystyrene, designated as Styron 411, to replace Styron K-27. There will be no increase in price of the new product. According to the release, molders will find in the use of the new material easier mold release, improved surfaces, exceptional welds, better flow control, elimination of the need for external lubrication and increased machinability.

**Sorry!**

★ MR. M. L. MACHT, AUTHOR OF the article "Molding methyl methacrylate resins" which appeared on page 112 of the September issue, is technical service engineer, Plastics Department, E. I. du Pont de Nemours & Co., Inc., not technical service director of that department.

★ WE REGRET THAT IN THE ARTIcle "Molded wrist watch straps" which appeared on page 106 of the August issue, the material was described as polystyrene in two of the captions instead of polythene.

(*Please turn to the next page*)

If any of our readers who have entered the plastics field during the past year wish to be included in the annual directory of the 1946 MODERN PLASTICS CATALOG, we urge them to request a listing blank immediately. No cost or obligation is involved. Address Plastics Catalogue Corporation, 122 East 42nd St., New York 17, N. Y.

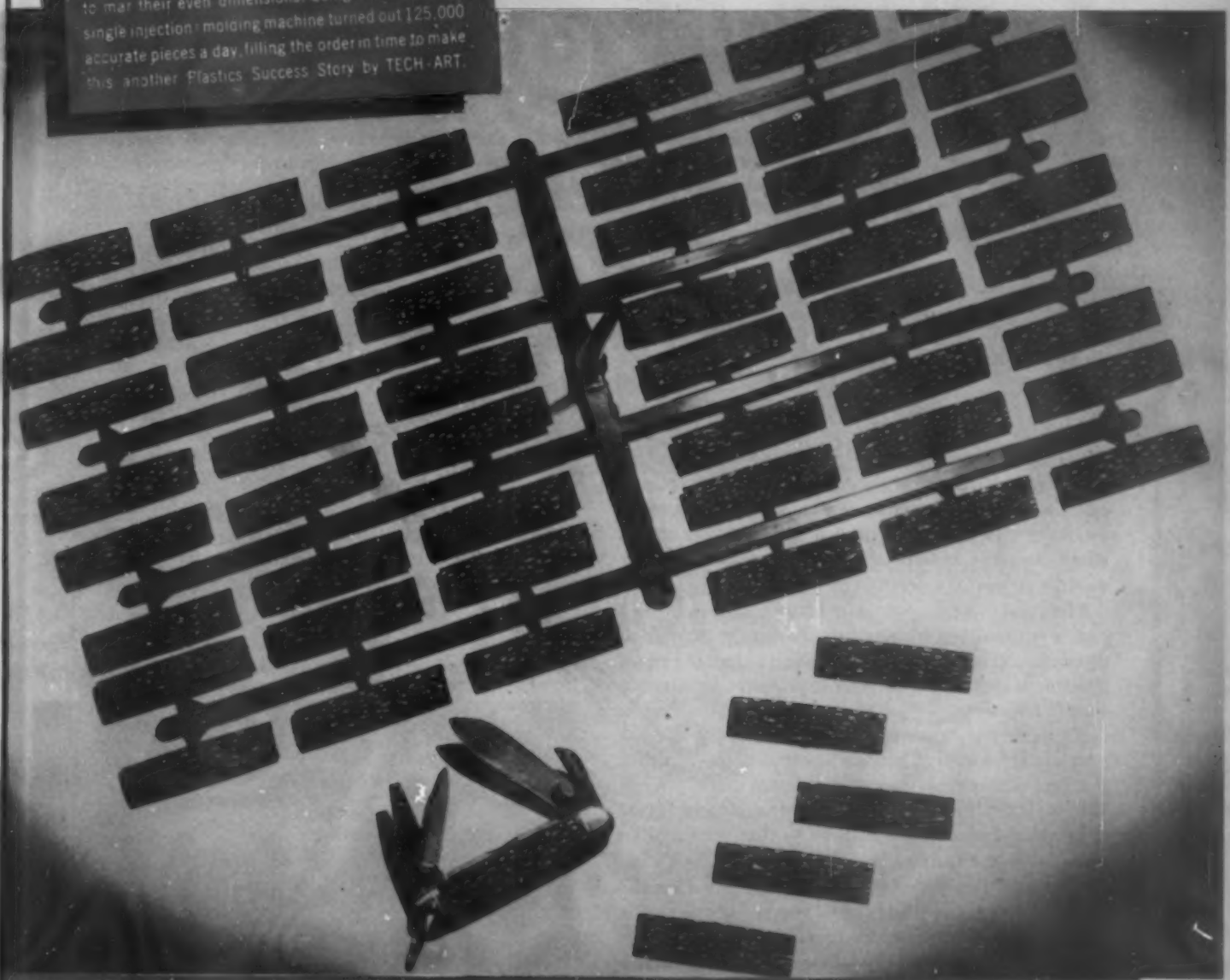
Listings include materials and chemicals, equipment and supplies, machine tools, machinery, molders, extruders, fabricators, laminators, consultants, testing laboratories, industrial designers, molders' markings and trade names.

# "Gated" for Mass Production . . .
# MOLDED *in* PLASTICS

## Another Plastic Success Story

Turning out these pieces in mass production quantities was TECH-ART engineers' biggest problem on this job. Calculations showed that a mold might be gated to produce 48 pieces at a clip — if it could be built accurately enough to distribute the injected plastic evenly to its farthest corners. TECH-ART engineers thought it could be done. Starting out with 1500 pounds of molding steel, TECH-ART mold builders fashioned the mold with watch-like precision, paying particular attention to the machining of the gates. The resulting pieces, produced on a flat mold, gave each cavity a perfect fill, left no unbalanced shrinkage in any part of the distributing channels, and produced clean pieces without a spot to mar their even dimensions. Using these molds, a single injection molding machine turned out 125,000 accurate pieces a day, filling the order in time to make this another Plastics Success Story by TECH-ART.

**The unusual production** technique illustrated here was no hit-or-miss proposition. Devised to overcome a problem of mass-production, it indicates that plastics molding, while it has its limitations, also has many novel possibilities in the hands of skilled engineers and mold building craftsmen. It is this knowledge of the possibilities of plastics molding which helps TECH-ART's engineers, mold builders and production men to bring a fresh, flexible viewpoint to each new molding problem—and to come out with the right answers wherever dimensional accuracy, appearance, simplification of design, speed of production or product serviceability is desired.



TECHNICAL NOTES — These military knife handles were molded from a high-impact plastic, specified because of its tough, non-cracking characteristics, good appearance, and general resistance to wear.

36th Ave. and 41st Street • LONG ISLAND CITY, N. Y. • Tel. AStoria 8-6050-1
SUCCESSORS TO BOONTON RUBBER MANUFACTURING COMPANY
PIONEER PLASTIC MOLDERS . . . Established 1891

TECH-ART PLASTICS COMPANY

★ INDUSTRIAL ACID WASTE, AN important factor in pollution of the Delaware River, will be transformed into much-needed fertilizer at the non-profit ammonium sulfate plant under construction by Rohm & Haas Co., Philadelphia 5, Pa.

★ E. A. WEINMAN, PLASTICS ENgineer, formerly with Virginia Lincoln Corp., is now associated with the Plastics Division of York Research Corp., New York 7, N. Y.

★ UNDER THE DIRECTION OF Sam L. Brous, newly appointed sales manager of the new thermosetting resin division, B. F. Goodrich Chemical Co., Cleveland 15, Ohio, will promote those resins, as distinguished from the company's Geon family of thermoplastic materials. Another recent appointment puts Dr. Benjamin S. Garvey, Jr., in the position of technical service manager of rubber chemicals.

★ NATURAL GASES ARE THE RAW material of the new process for production of chemicals which Celanese Corp. of America, New York 16, N. Y., is starting on a large scale at its new plant in Bishop, Texas. The principal chemicals produced are acetic acid, acetic anhydride, acetone, methanol and formaldehyde, all of which were previously made from petroleum raw materials. A second unit of the chemical plant will be devoted exclusively to the manufacture of butadiene, chief ingredient in the making of Buna-S synthetic rubber.

★ TOWARD THE PROMOTION OF a better understanding of electronics, General Electric Co., Schenectady, N. Y., is offering a training course in industrial electronics in the form of 12 sound slide films accompanied by 25 sets of 12 review booklets each keyed to a film. Phrased in non-technical terms, the course offers a practical, easily understood presentation of the subject and devotes considerable time to the development of fundamental concepts. Purchases may be made through the general office of the company.

★ VULCANIZED RUBBER CO., NEW York 16, N. Y., will henceforth be known as Vulcanized Rubber and Plastics Co., according to a recent announcement.

★ INCREASED OUTPUT DUE TO improvements in manufacturing methods has resulted in price reductions averaging 30 percent in several types of neoprene synthetic rubber latex, according to an announcement by Rubber Chemicals Div., E. I. du Pont de Nemours & Co., Arlington, N. J. This step brings the principal neoprene latex, known as Type 571 down to 25 cents a pound, dry weight basis, in tank car lots, or 28 cents in drums in car lots. Price cuts on other types range from 24 to 33 percent.

★ GOODYEAR TIRE & RUBBER Co., Akron, Ohio, has revealed plans for the construction at Niagara Falls, N. Y., of a vinyl plastics plant which is expected to have a production capacity of three million pounds per year. Materials produced will be shipped to other plants to be processed for manufacture into transparent packaging film, wire insulation, fabric coatings, flooring, wall coverings as well as adhesives.

★ GENERAL PLASTICS CORP., Marion, Ind., has announced the enlarging of its facilities for forming acetate, acrylic and other thermoplastic sheet stock.

★ PULP AND PAPER TECHNOLOGY will be the subject of a graduate lecture course to be offered evenings by the Department of Chemical Engineering of the Polytechnic Institute of Brooklyn, N. Y., beginning on October 4. Given under the direction of Robert S. Aries, the course will emphasize specialty and coated papers, the combination of plastics and resins with paper, correct methods of testing pulp products.

## *A protective coating for metals*

A NEW plastic is currently being used by West Coast manufacturers as a protective covering to prevent scratches, mars and corrosion on metals such as steel, aluminum and magnesium. While this has been the principal use of the coating to date, the plastic can also be used to protect china, glassware and other products with glazed or polished surfaces. Its cost is about the same as that of the oils or greases normally used to prevent corrosion.

Plastipeel is a cold-pour, vinyl-base compound which can be applied like lacquer by spraying, brushing and dipping. Normally, it is transparent; but it can be dyed or tinted any color. It is produced by Duorite Plastic Industries.

At room temperatures, the compound dries in approximately 20 min., leaving a film that is not disturbed if the metal it covers is bent to a different shape. While the film is readily peeled off with the fingernails, it can, if necessary, be cured with heat so that it cannot be removed except through the use of solvents.

This vinyl-base coating can be handled like a varnish when it is to be applied with a brush. If the plastic is to be applied to the metal by dipping, a tank which can be kept tightly covered when not in use should be used. The tank can be constructed of almost any material but plastics. Spraying has proved most successful when the air pressure is maintained at 30 to 40 lb. for atomizing and 6 to 10 lb. for feed pressure. As a rule, the spray head[1] should be held about 10 in. from the material. If the metal begins to cobweb, the spray gun should be moved closer and the air pressure adjusted accordingly.

The minimum thickness of the Plastipeel film is 0.003 in., and this can normally be attained with a single coating. If it is flat and smooth, the thickness should be 0.003 to 0.005 inch. If it is contoured or rough, the thickness is inadequate, or the coating is somewhat difficult to remove with the fingernails.

[1] DeVilbiss Type P-QN containers and Type PDNB spray heads have been used successfully for the work.

PHOTO, COURTESY DUORITE PLASTIC INDUSTRIES

THERMEX RED HEADS constitute a really complete line of portable, self-contained, simple, high frequency plastics heating units from which to meet your needs.

From the smallest production model, 15 inches wide, to the largest in the field, capable of raising 7 pounds of average material 170 degrees in one minute! Small or large, compact in relation to capacity, they're all portable—easy to move around, easy to fit into existing press arrangements. All with the built-in drawer heating compartment, they're easy to operate—the heat turns on when drawer is closed, automatically stops when the time cycle is completed.

Mail the coupon or contact Girdler Corporation branch offices at 150 Broadway, New York 7, New York, 228 N. LaSalle St., Chicago 1, Illinois, 1836 Euclid Avenue, Cleveland 15, Ohio.

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# Three-part indicating dials

MACHINES and tools are not generally thought to need adjustment to adapt them to operation in different countries. Yet such is the case. For example, the indicating dials on the milling machine shown in Fig. 2 must be changed so that they bear the markings of the system of measurement accepted in the country in which they are to operate. Thus, the numbering will follow either the Imperial or Metric systems depending upon whether the machine is to be used in the United States and England, or in the other countries of the world. Then too, the markings on these dials are changed according to the type of operations that are expected of a machine of the type illustrated.

*Above—The assembled indicating dial (shown, top); cap and base (left); and ring (right). The cap and the base are compression molded of phenolic while the numbered ring is injection molded of cellulose acetate*

*Below—Each milling machine employs two indicating dials which must bear the system of measurement peculiar to the country in which they are used, or the particular application for which the machine is intended*

PHOTO, COURTESY RECTO MOLDED PRODUCTS, INC.

Two of these dials, consisting of a cap, base and ring, are used on each milling machine. The cap, which is grooved on the top much like a screw head, is compression molded of a red phenolic flour material supplied by Bakelite. The dial base, also compression molded, uses a pellet-type paper base phenolic, 1900 Durez. This black part has gear teeth molded on its inner surface which mesh with a die cast gear on the milling machine. It is the gear system that operates the hydromatic control of the miller and must therefore be capable of adjustment.

A Fibestos ring, the third part of this assembly, has numerals molded in from the back. To make possible the snug assembly of this injection molded ring and the molded black phenolic base, a recess is molded on the outside diameter of the base so that the number ring nests directly in it. An undercut is machined in the upper edge of this recess so that when the number ring is stretched into position over the recess, its upper edge ring snaps permanently into place.

The production of the injection-molded Fibestos ring on this indicator dial involves a number of interesting operations. Seventeen different force plugs are needed for the molding of this part because of the different numerical distinctions which are needed to fit the part for use in various countries and for the various operations this machine is capable of performing.

The inside of this numeral ring is designed so that each group of numerals is molded in a rectangular pad which is raised somewhat away from the surface of the inside periphery. In order to make the numerals clearly visible, it was decided to use three colors on the ring. White is used for the numbers themselves, black for the area of the pads around each set of numbers, and red for the remaining surfaces of the ring. In the painting operation white paint is daubed on each raised pad thereby filling the depressions which are made by the molded numerals. Next, the valleys between and around the pads are painted black. The surface of each pad is then sanded, an operation which leaves white paint only in the depressed numerals. After this, the entire inside surface of the ring is sprayed with red paint which shows through the transparent ring wherever its inner surface has not already been coated with white and black, that is, on the numerals and pads.

All the work on this indicating dial, including the molding and finishing, is done by Recto Molded Products, Inc. This company has devised an ingenious method of preventing the three different paints that are used on the cellulose acetate ring from putting its neighbor into solution. This consists of using three different paint bases. The white paint has a japan base, the black paint an oil base and the red paint a lacquer base.

Because of the angle on which the numerals are molded in the number ring, the construction of the force plugs presented somewhat of a problem. Of course, the force plug was a straight drawing. Since the various sets of numerals were on an angle, it was necessary for each numeral to be carefully engraved on the plug to avoid the molding of an undercut.

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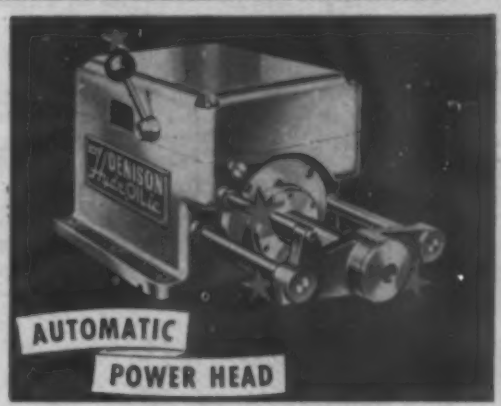


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# Adhesives and adhesions

(*Continued from page 157*) many of the properties of a given wood depend on the nature and amount of its lignin component.

*Natural and synthetic high polymers*—High polymeric materials include all substances which may be considered as consisting of large multiples of monomeric units, formed either by polymerization or condensation. Cellulose, rubber and vinyl resins are examples of polymeric materials. There are two types of high polymeric compounds:

*Thermoplastic*—two-dimensional molecules

*Thermosetting*—three-dimensional molecules

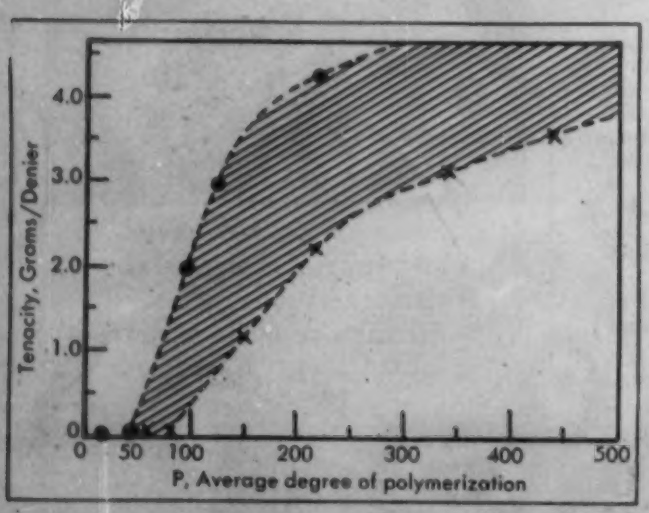
These two classes of materials have arrangements somewhat analogous to those of asbestos and diamond, respectively.

1. *Thermoplastic polymers*[13]. If the attractive forces between chains are strong and the fine structure permits of easy lattice formation, a high degree of crystallinity and hence cohesion will result. Such materials fall in the fibrous area of Fig. 3. In fibers such as cellulose the individual chains are probably held together by means of hydrogen bonds through the OH groups. Other fibers of high strength, such as nylon, are probably joined by similar forces.

The forces between molecules of polystyrene, polymethyl methacrylate, and related materials are not so great as those between cellulose and nylon molecules. These materials fall in the plastic area of Fig. 3. There are no very reactive centers, such as hydroxyl or amido groups for forming hydrogen bridges between chains. The most likely assumption to explain their strength in films, filaments, etc., is that they are held together by van der Waals forces which are strong because of the great asymmetry of the monomer molecules. The vinyl polymers are not as asymmetric as polystyrene or methyl methacrylate and they tend toward rubbery characteristics.

Rubbery materials owe their properties to very much weaker van der Waals forces between the molecular chains. A tensile load applied to a rubber causes an actual change in the configurations of the chains; the coiled equilibrium state is changed to the stressed chain state. These materials are located in the rubbery area of Fig. 3.

2. *Thermosetting Polymers.* Cured thermosetting resinous materials, such as phenol-formaldehyde and urea-formaldehyde condensates, are composed of a three-dimensional cross-linked network, analagous to the diamond structure.




*3—Effect of average degree of polymerization on tenacity of high polymers. (From Mark).*

In order for such a structure to be formed, it is necessary that at least one of the reactants in the polymerization mixture have three or more active centers at which bond formation can occur. In phenol-formaldehyde resin, for example, the benzene ring is capable of forming bonds at the para and two ortho positions with respect to the hydroxyl group. The cohesive forces in such a material are very strong covalent bonds, and consequently the gross physical properties are those of great strength and stability.

## The Nature of Adhesion

The investigation into the nature of adhesion has as its objective the establishment of the most desirable physical and chemical properties for an adhesive between two given surfaces so that maximum structural strength can be obtained. In the past two decades considerable interest has been aroused in this subject. Probably the greatest effort in this direction was that undertaken in Great Britain, the results of which are described in the three reports of the Adhesives Research Committee under the auspices of the Department of Scientific and Industrial Research. The greater part of this investigation was conducted by J. W. McBain and coworkers.[14] At the same time work was being done in this country at the U. S. Forest Products Laboratory by F. L. Browne and T. R. Truax. Both organizations were interested in the mechanism whereby two surfaces of an adhesively formed joint are held by the adhesive.

McBain, as a result of his investigations, arrived at the conclusion that two types of bonded joints may be formed:

*Mechanical*—between porous surfaces

*Specific*—between smooth, dense surfaces

Browne and Truax,[15, 16] however, maintained that although some of the strength of the bond between two porous surfaces must be attributed to tendrils of adhesive which enter the pores, this mechanical interpenetration cannot account for more than a small fraction of the joint strength.

*McBain's experimental work*—McBain drew his conclusions from the following experiments:

1. McBain prepared joints between surfaces of silver to silver and silver to wood. He varied the character of the silver surface by welding silver gauze at several points in single and double layers to the smooth surface and obtained qualitative results for the strength of bonds prepared with a proprietary gelatin glue:

| *Joint*[a] | *Strength* | *Remarks* |
|---|---|---|
| 1. Ag:glue:Ag | 0 | Glue film moist |
| 2. $(Ag)_s$:glue:$(Ag)_s$ | 0 | Glue film moist |
| 3. Ag:glue:wood | 0 | Glue film only on wood when joint was broken |
| 4. $(Ag)_s$:glue:wood | Weak | Stronger than 3; glue film partly on silver gauze and partly on wood |
| 5. $(Ag)_{ss}$:glue:wood | Moderate | Stronger than 3 or 4; glue film partly on silver gauze and partly on wood |

[a] $(Ag)_s$ = Silver to which was welded one layer of gauze.
$(Ag)_{ss}$ = Silver to which was welded two layers of gauze.

Similar results were obtained using gum arabic and molten shellac, respectively, as adhesives.

2. Surfaces of hard and soft woods were treated with three successive coatings of ebony stain before bonding and the joint strengths were compared with those of unstained surfaces by breaking manually. In the case of soft woods the

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joints prepared with either the stained or the unstained surfaces could not be broken by hand, but in the case of the hardwoods, the stained joints broke. McBain concluded that the stain was able to fill the pores of the hardwoods, but not of the soft woods, thus preventing mechanical penetration by the glue of the hardwoods, which consequently gave weak joints.

3. If adhesion to porous surfaces is mechanical, the joint strength must be directly related to the tensile strength of the glue. McBain, using the method of Farrow and Swan,[17] prepared adhesive films by casting on thinly greased ferrotype plates. Films and specimens of bonded walnut wood prepared with a sodium silicate glue and an animal glue, with and without the addition of dextrose, respectively, had the following strengths:

| *Glue* | *Strength* | | |
|---|---|---|---|
| | *Glue film in tension* | *Walnut joints* | |
| | | *Shear* | *Tension* |
| | *p.s.i.* | *p.s.i.* | *p.s.i.* |
| 1. Animal glue | 12,000 | 1500 | 825 |
| 2. Animal glue mixed with an equal part of dextrose | Less than 1000 | 600 | 420 |
| 3. Sodium silicate | 600 | 700 | ... |

4. Specific adhesion requires wetting of the surface not only by the solvent, but also by the glue. McBain attempted to show that gelatin does not wet several porous surfaces with which it forms strong joints.[18, 19] To do this he measured the water absorption of filter paper, viscose rayon and fused silica, and then measured the change in concentration brought about by the addition of these materials to aqueous solutions of glue. He found that only with fused silica did the concentration become lowered. This he interpreted as showing that water was being removed from the solution by porous substances such as filter paper and viscose rayon, but no glue was being adsorbed.

5. McBain believed that if specific adhesion is operative, the attractive field of the solid surface should impose an orienting influence upon the molecules of the very thin adhesive layer. In such a case the glue structure should differ in a glue line from that of a solid block of glue. Studies of x-ray patterns from glue films on wood revealed no such difference.

*Forest Products Laboratory experimental work*—Browne, Truax and other workers gave the following interpretation to these experiments:

1. Some degree of specific adhesion is a necessary prerequisite of mechanical adhesion in the case of materials having such a fine degree of porosity as wood. Red oak surfaces, selected because of the large pores, were joined with Lipowitz metal alloy[18] which has a melting point of 60° C., does not wet wood, and has a viscosity not unlike that of woodworking glues. The joint was easily separated by hand and the film was removed intact.

Glue solutions contain considerable volumes of water or other solvents. As the joint dries, the glue contracts throughout its entire mass. If the interpenetrating tendrils did not adhere tenaciously to the cell walls, they would shrivel and the entire interface between wood and adhesive would disintegrate. Photomicrographs of glued sections showed that in all cases the glue had remained attached to the cell walls and in drying had contracted from the center of each tendril, leaving a hollow cylinder.

2. In the staining of hard and soft woods prior to gluing, the pine probably absorbed the oil stain more readily than did the mahogany; thus enough of the surface of the pine was unaffected to form a good joint. If sandpaper were used to clean the stained mahogany surfaces, the filled pores would be unaffected, whereas cells of the wood would be exposed on the surface to be bonded. McBain's experiment was repeated using paraffin wax and collodion, respectively, to seal the pores and the surfaces were sanded before gluing. Good joints were obtained although penetration was greatly reduced as evidenced by photomicrographs.

3. McBain's relationship between the tensile strength of glue films and the shear and tensile strength values of glue joints was based on an experiment in which gluing methods assuming mechanical adhesion were used. Thus the glue was prepared in a thin solution, applied hot to heated wood surfaces and pressed immediately in order to fill the wood as much as possible with glue.

This experiment was repeated on several species of wood glued with sodium silicate, animal glue, and animal glue containing two concentrations of dextrose. The tensile strength of walnut joints, and the shear strength of maple joints glued with these substances is as follows:

| *Glue* | *Strength* | | |
|---|---|---|---|
| | *Glue film in tension*[a] | *Wood joints* | |
| | | *Shear*[b] | *Tension*[c] |
| | *p.s.i.* | *p.s.i.* | *p.s.i.* |
| 1. Animal glue | 12,000 | 3950 | 1400 |
| 2. Animal glue–dextrose mixed (1:1) | Less than 1000 | 3350 | 1300 |
| 3. Animal glue–dextrose mixed (1:1.5) | ... | 3150 | ... |
| 4. Sodium silicate | 600 | 3000 | 950 |

[a] Values determined by McBain.
[b] Maple block shear.
[c] Walnut joints.

In each case the glue was applied in concentrated solution to one surface, allowed to dry until the glue line retained a fingerprint and then assembled. The joints so obtained were much stronger than those of McBain. Although there is some loss in joint strength when the glue is weakened, this loss is not so great as indicated by McBain and, furthermore, the greater number of failures in these joints occurred in the body of the glue and not at the interface between the glue and the wood, so that the failure was not one of adhesion.

4. McBain's conclusion regarding the lack of adsorption of gelatin from aqueous solution is not necessarily correct. If water is more attracted to wood than is the gelatin, it will be selectively adsorbed from solution, thus giving the appearance of negative adsorption for gelatin.

Campbell[20] has recently advanced the theory that glue is adsorbed to wood surfaces through a monomolecular layer of water which is directly attached to groups on both the wood and glue surfaces.

5. Although the Forest Products Laboratory workers did not comment on McBain's fifth experiment, later investigators studying the effect of surfaces on lubricant films have found that attractive forces between a surface and an adsorbed layer do not operate through much more than a monomolecular layer of the liquid.[21] This is in agreement with the findings of Lennard-Jones[3] who calculates the electrostatic attraction between surfaces and charged particles. In such a disorganized macroscopic system as an animal glue film it is

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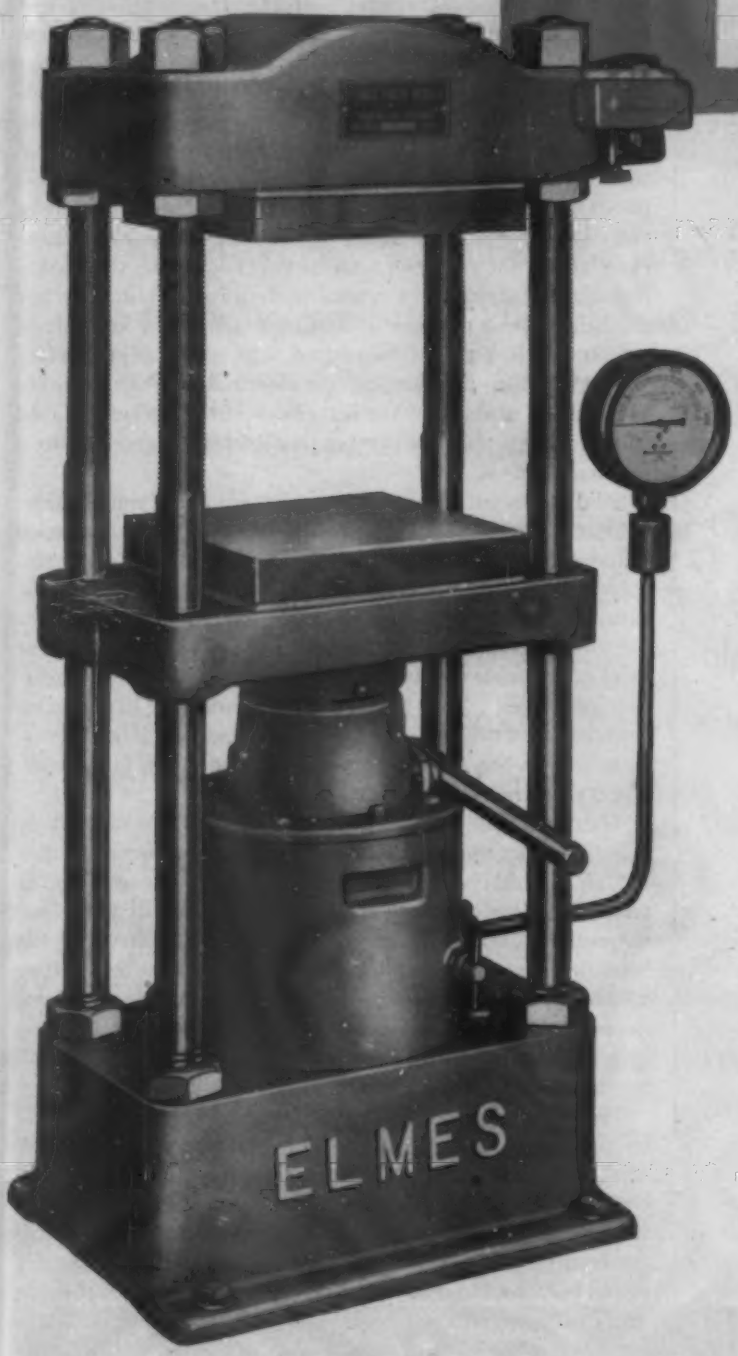


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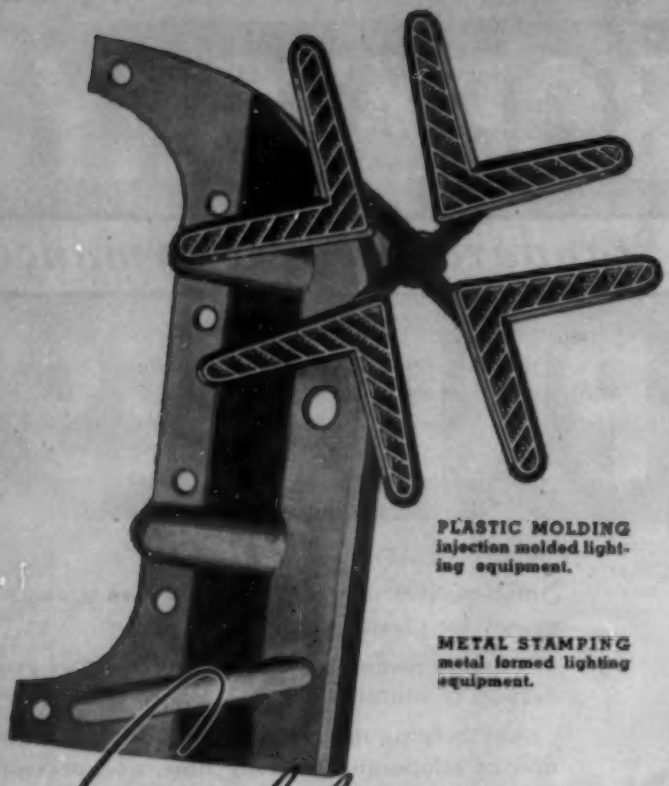

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not likely that orientation effects present in a monomolecular layer could be detected by the method used by McBain.

### The chemical properties of surfaces [10]

It has been shown that adhesion to any porous surface is not primarily a mechanical phenomenon. Evidence is accumulating in every pertinent field that molecular attractive forces are responsible for the bond between any two surfaces. A knowledge of the chemical nature of surfaces is necessary in order to establish the type of bond formation which may occur.

The surfaces of solids are entirely different from their internal structures. The simple treatments of grinding and polishing differ very greatly in their effects on surface nature. In metals, especially, x-ray diffraction patterns show that grinding removes sections of the surface without appreciable distortion of the remaining crystal structure, whereas polishing removes the promontories and deposits materials from them in the crevasses, leaving a smooth transparent amorphous film known as the Beilby layer. This layer has more of the characteristics of a liquid than a solid and is much more reactive. If, for example, a metal vapor is condensed upon a polished metal surface, a crystal pattern is first obtained, but on standing this changes to that of a completely amorphous structure. If a nail is hammered into a crystalline surface the amorphous ring around the hole will be more readily attacked by acids than the remainder of the surface. Glass surfaces when polished are rendered doubly refracting to a depth of 3000 Å.

Solid surfaces are very irregular in their constitution. Thus, the surface of even a monocrystalline metal will contain different faces, edges, corners and projections. For this reason all parts of a given surface will not have the same catalyzing ability and consequently the same degree of affinity for adhesive substances. Experiments show that different faces of the same crystal exert very different forms of attraction upon dyes. Thus if lead nitrate is immersed in a solution containing methylene blue and picric acid, some of the surfaces will be blue and some yellow; neither film is contaminated with traces of the other dye.

The greater the activity a surface possesses, the more likely it is to be contaminated with impurities which are present in the air. Freshly split mica surfaces will seize each other tenaciously, but if they are freely exposed to circulating air currents they lose this activity after a few minutes. It has been demonstrated that if these surfaces are covered, they will retain their attraction for each other for several days. Accidental traces of grease will greatly reduce the wetting properties of such surfaces and even slight contamination will increase the contact angle with a liquid.

The purification of a surface is, consequently, of the greatest importance if strong tenacious glue lines are to be obtained. This is by no means a simple operation. It is possible to clean the surface of glass by heating with a flame for a short time provided the contamination is not excessive, but this treatment cannot be applied to most other surfaces as they would become sintered. Metals may be cleaned with benzene or by slight etching with acids followed by washing with distilled water and drying with alcohol and ether. It has been demonstrated experimentally at the Curtiss-Wright Laboratories that sanding of wood surfaces with the finest grade of sandpaper immediately before gluing gives a much better bond than that obtained with glazed surfaces produced by planing or with roughly sanded ones; thus the sanding operation is one of cleansing. (*Please turn to next page*)

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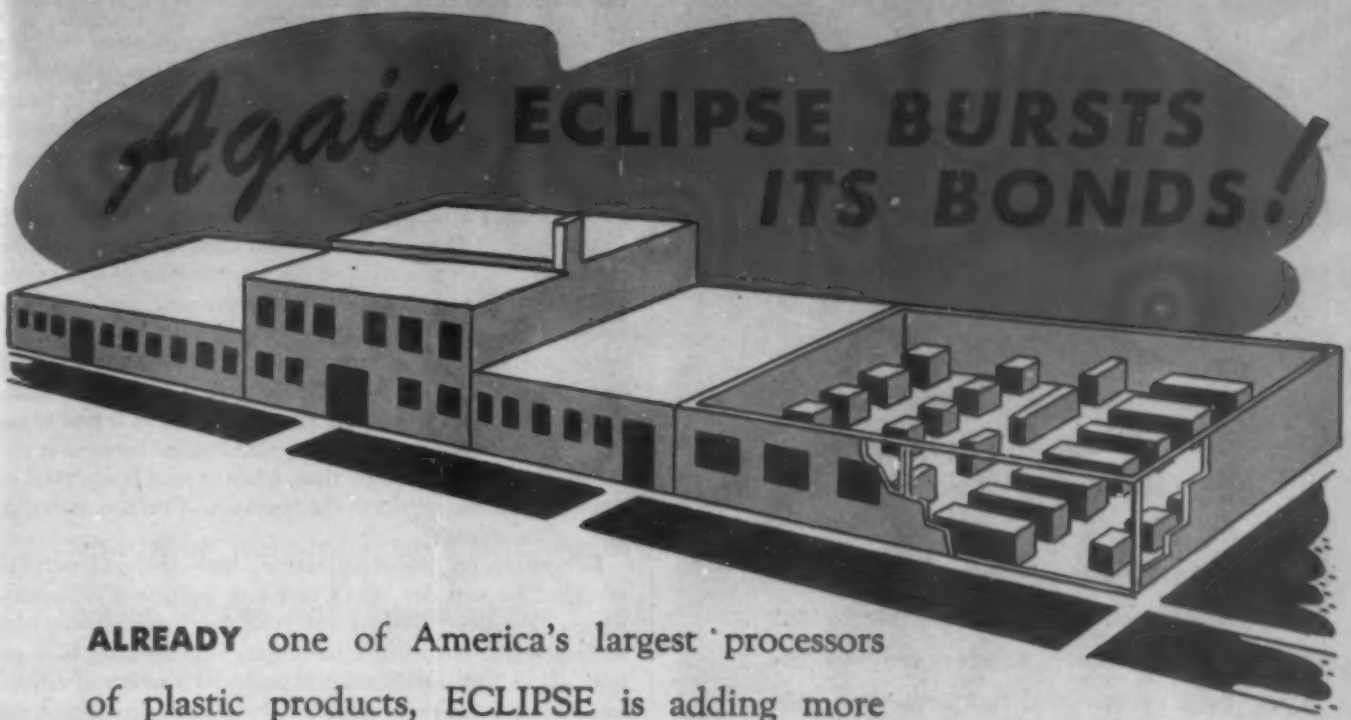

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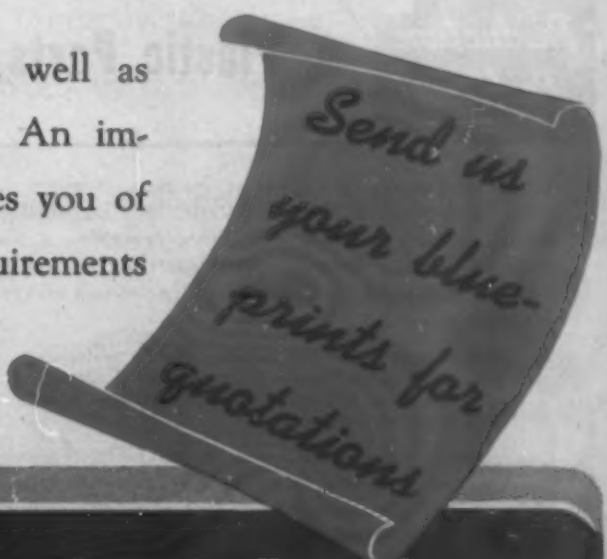


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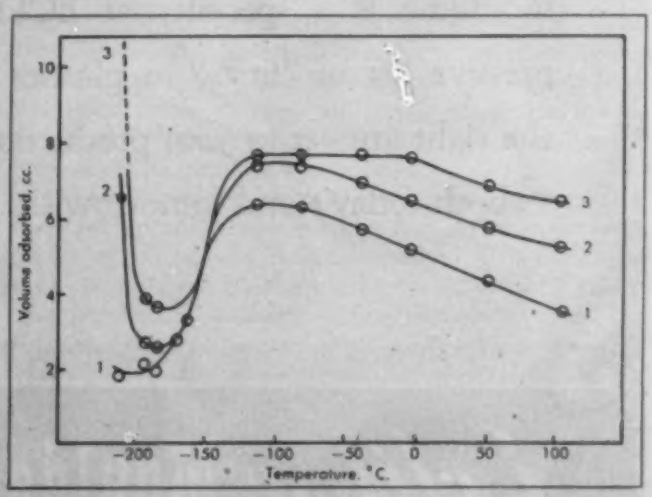
## The mechanism of absorption

*Adsorption phenomena, general*—Determination of the heats of adsorption and chemical investigation of adsorbed films on solid surfaces show that two distinct types of forces are involved. When a gas is attracted to a surface by means of van der Waals forces, the heat of adsorption is 4000 calories per mole or less and the variation of a few degrees in temperature results in a simple pumping off of part of the film. If, on the other hand, an actual covalent bond is formed, as is the case with oxygen adsorbed on carbon, the heat of adsorption will be of the order of 10,000 calories per mole and may even reach as high a value as 200,000 calories per mole. In this latter case, the temperature required to release the adsorbed film is sufficient to pyrolyze the chemical bond. Very frequently this bond is stronger than the cohesive bonds of the adsorbing material and the compound formed between it and the gas is released as such; thus, when oxygen is adsorbed on charcoal, heating results in the liberation of carbon monoxide and carbon dioxide.

Depending on the temperature, the same gas may be adsorbed by van der Waals forces or by primary chemical forces. Polanyi[23] pointed out that the free valences of a surface would not attract the impinging molecules of a gas until these had surmounted a potential barrier. In other words, only those molecules which have a certain energy value will combine chemically with the surface. This relationship is well illustrated by the behavior of hydrogen on nickel at various temperatures between −200 and 100° C. at different pressures. Thus at 600 millimeter pressure the curve of volume adsorbed plotted against temperature is given in Fig. 4.[23] At −190 to −180° C., adsorption takes place almost instantanequsly through van der Waals forces. The amount of gas adsorbed decreased to a minimum at about −160° C. because of the increase in kinetic energy of the gas molecules. Above −160° C. primary bond formation begins to occur. Adsorption reaches a constant value between −110 and 0° C. Further increase in temperature results in the pyrolysis of the chemical bonds.

*Adsorption phenomena at glue lines*—It is evident that the primary consideration in selecting a suitable adhesive for a given surface is an evaluation of the relationship between active groups on the molecules of the adhesive and the surface. At the present time the difficulties involved in measuring the exact area of a solid surface and the lack of knowledge with




*4—Adsorption of hydrogen on nickel. (From Benton and White). Curve 1: 25 mm. pressure. Curve 2: 200 mm. pressure. Curve 3: 600 mm. pressure*

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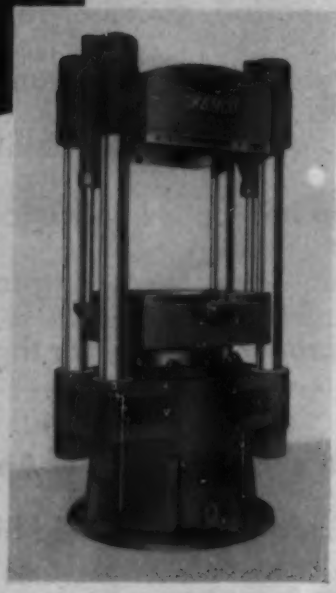

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respect to the configurations, molecular weights and kinetic behavior of high polymeric substances make it impossible to define mathematically the total bond energy at a glue line interface. It should be possible, however, to construct a theoretical picture of this region which would lead to a better understanding of the phenomenon of gluing.

*Metals to metals (direct)*—The art of metal bonding depends very greatly on the uses of solders and welds. The chemistry of alloy formation furnishes considerable information on the nature of the attractive forces involved. If two metals are very closely related, e.g., copper and gold, atoms of the one will replace atoms of the other in a crystal. When there are certain definite proportions, e.g., CuAu and $Cu_3Au$, the distribution in the crystal will resemble that of an ionic compound such as NaCl. If the metals are dissimilar they may actually form chemical compounds which have their own crystal structure and have chemical and physical properties which are quite different from those of the constituent elements. Thus the melting points of sodium and mercury are 97.5 and −38.7° C., respectively, whereas the substance $Hg_2Na$ melts at 360° C.

Although the exact relationships which hold in the crystalline state are not precisely those obtained in a soldered or welded joint, the same general laws apply. Thus the experience with solders has been that the strongest and most permanent bonds are formed between metals having optimum chemical affinity.[24] In all cases where the metal surface remains solid, a good bond with the liquid solder is best obtained when a wetting agent or flux is employed to cleanse the interface.

*Metals to enamels*—When metals are glazed with vitreous enamels, it has been observed that the ground coat between the metal and the glaze must contain cobalt or a similar oxide. The role of the cobalt compound has been the subject of much controversy, but a plausible theory is that it serves as a catalyst in forming the bonds between atoms of the metal and oxygen atoms which are attached to silicon in the enamel. The interfacial bond between a vitreous and a metallic surface, according to Weyl[25] must be of the chemical type in order to explain the stability of such a system. King[26] has reported that in the case of good bonding between iron and enamels, atoms of iron partially penetrate into the enamel in the form of dendrites which remain attached to the iron surface.

*Metals to rubber*—It has long been known that extremely good bonds are obtained by vulcanizing rubber onto certain metallic surfaces. Evidence shows that the rubber is actually attached to the surface through a sulfur bridge. The bond is obtained more easily with brass than with iron,[27] a fact which correlates with the greater ease of the sulfide formation of copper and zinc than of iron.

*Metals to resinous adhesives*—An example of primary bond formation between a resin and a metal surface has been described by Doolittle and Powell.[28] These workers developed a vinyl chloride-acetate copolymer resin (VNCH) for use as a metal lacquer by polymerizing a small amount of maleic acid with resin, thus giving free carboxyl groups on the chain ends of the polymer. The amount of acid must be controlled to a small proportion, because 5 percent or over causes excessive corrosion of the metal. As low as 0.1 percent, however, gives improved adhesion and the optimum amounts are between 0.3 to 1.0 percent. That the carboxyl group is responsible for adhesion was proved by forming the

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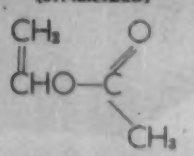

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sodium salt of the resin, thereby destroying its adhesive properties. Diesters of the acid showed poor adhesion, but monoesters were almost as effective as the acid itself. This development is an excellent example of just what may be expected to result from a careful study of the chemical nature of adhesion.

In his work for the Adhesives Committee, McBain investigated the adhesion of a large number of substances to metals. He found a close relationship between the atomic volume of the metal and the bond strength of a given adhesive. With shellac, for example, there is almost a linear relationship between atomic volume and tensile strength of the joint, as shown by the following data:

| *Metal* | *Atomic volume* | *Tensile strength of shellac-glued joint* |
|---|---|---|
| | | *p.s.i.* |
| Nickel | 6.7 | 3500 |
| Copper | 7.1 | 3300 |
| Aluminum | 10.1 | 2800 |
| Tin | 16.2 | 1100 |
| Lead | 18.2 | 600 |

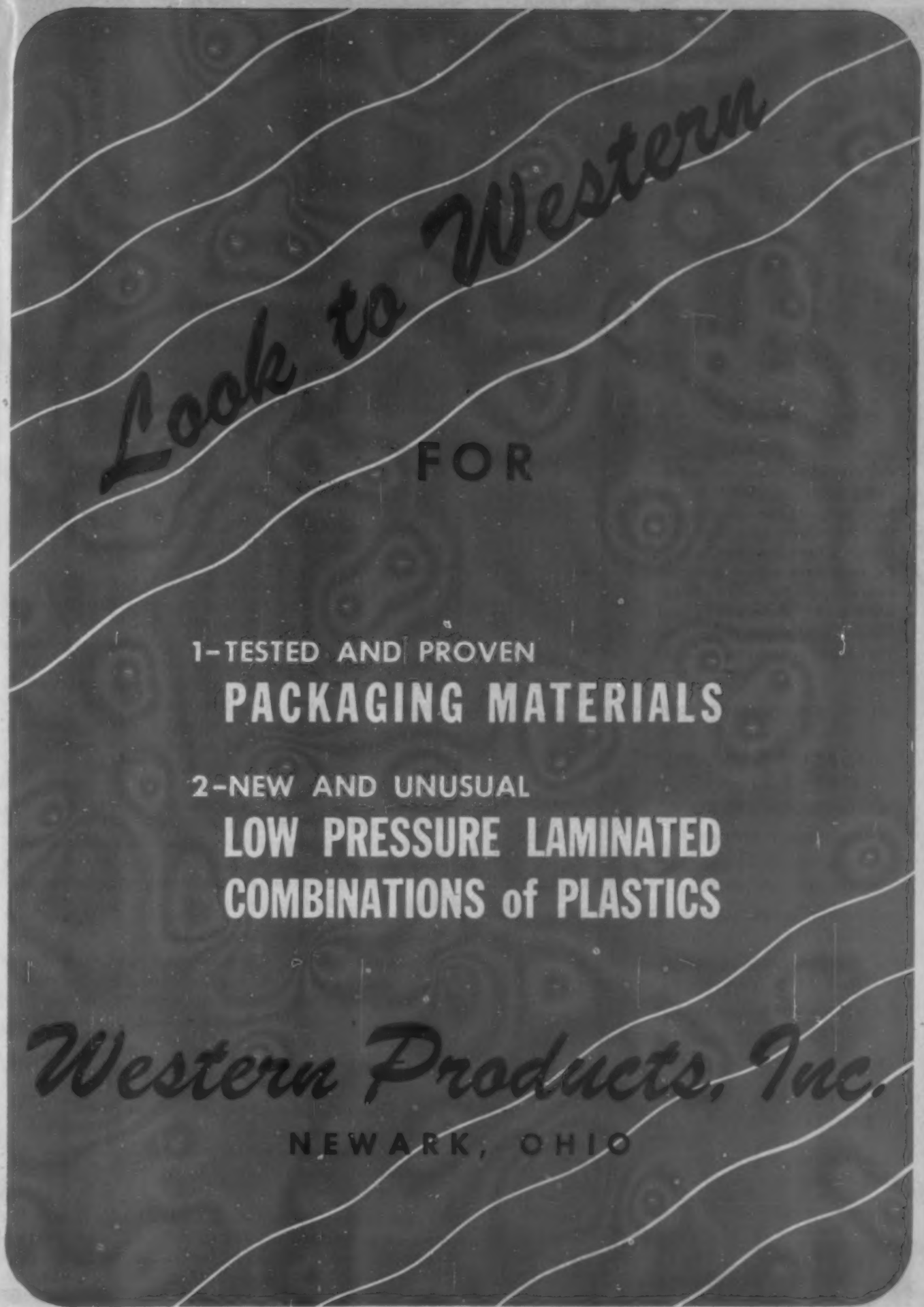
Investigators at the Resinous Products and Chemical Company have found that Redux joints are stronger with high valency metals than with low, and that with different grades of steel the adhesion is poorest with those which oxidize readily such as silicon steel.

*Wood to adhesives*—Adhesives for wood have been more thoroughly investigated than for any other material. The mechanism for the bond between wood and phenolic resins, which is much stronger than the cohesive bonds of wood, is very probably hydrogen bridging between hydroxyl groups in the two materials. The reactivity of the phenolic hydroxyl groups is indicated by the fact that water-insoluble phenol-formaldehyde resin will dissolve readily in sodium hydroxide solutions of moderate concentration and even the cured resin is attacked by strong alkaline solutions.

The probable structure of urea-formaldehyde resins indicates that much of their bonding power resides in the amido ($-NH_2$) and imido ($=NH$) groups which are present in large numbers in the uncured state. These groups will also participate in hydrogen bonding to other amido, imido or hydroxyl groups. Campbell[39] postulates that, instead of direct bonding to cellulosic hydroxyls, a molecule of water serves as an intermediary bonding material between wood and urea resins. The rapid failure of such structures when subjected to alternate wetting and drying was regarded as evidence of such bonding. Introduction of high-boiling water-insoluble alcohols into the adhesive mixture was found to improve the resistance of the bond to delamination under the cyclic conditions.

*Wood and metal to adhesives*—Most adhesives which form satisfactory bonds to metals are not suitable for bonding wood and vice versa. Several adhesives have been developed recently, however, which consist of combinations of rubbers with phenolic resins. The bonding is accomplished by heat which cures the phenolic resin in a strong bond to the wood and the rubber to the metal.

It has been found by Cunneen, Farmer and Koch[39] that olefins form compounds with saligenin which is the precursor of phenol-formaldehyde resin. (*Please turn to next page*)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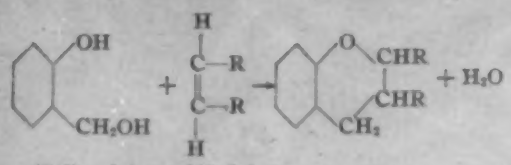
It has also been observed that an oxidized rubber reacts readily with maleic acid, phenol and formaldehyde to give a modified rubber-phenolic resin.[30]




(Saligenin) (Olefin)

A reaction between rubber and a curing phenolic resin probably occurs in this same manner, the terminal saligenin grouping of the resin attaching to the double bond in the surface molecules of the rubber. Thus a primary chemical bond would be formed, accounting for the high shear strength observed for these rubber-resin adhesives.

*Glass surfaces*—The effect of cobalt oxide in bonding vitreous enamels to metal has already been mentioned. Stannous chloride is used to promote adhesion in plating silver and other metallic films on glass. The strength of the bond between sodium silicate and glass indicates that primary chemical bonds are involved.

*Rubber surfaces*—Strong bonds may be obtained between rubber surfaces through van der Waals forces as well as through chemical bonds. In the first case a solution of rubber applied to a rubber surface leaves a fused structure which has good bond strength. In the second case, vulcanization proceeds across the interface of two rubber surfaces in the same manner as within the two original masses. This is evidenced by bond strength of vulcanized patches on tires.

*Plastic surfaces*—It has been found by Barkhuff and Carswell[31] that a thermosetting resin cured at one temperature gives evidence of further cure at a higher temperature. This indicates that such a resin may frequently retain a degree of reactivity which would be sufficient for chemical reaction at the surface with a curing thermosetting adhesive. In the bonding of any resinous surface cured in a mold or between press platens, it is very important to remove any waxes used in their fabrication from the surface in order to permit adsorption of the adhesive material.

Thermoplastic materials are usually swelled or dissolved by organic solvents. Consequently they may be bonded by the addition of a solvent which attacks both surfaces and allows an interdiffusion of the two materials. This permits the van der Waals attractive forces to exert a maximum effect brought about through hydrogen bridges.

## Determination of the nature of adhesion

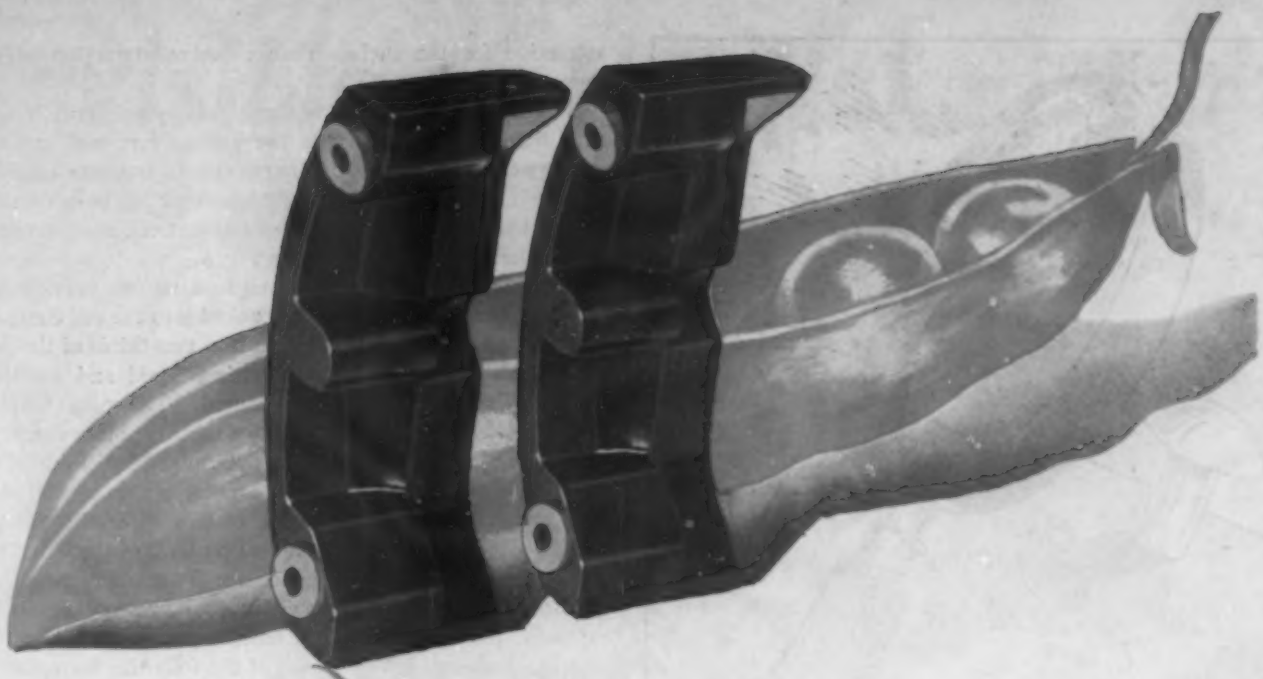
*Bartell Cell*[32]—It has long been known that the affinity of a solid substance for a liquid was directly related to the shape of a drop of the liquid on a smooth surface of the solid. By measuring the angle of contact it is possible to calculate the adhesion tension at the interface:

$$A_{1,2} = S_2 (\cos \theta) \qquad (1)$$

where:

$A$ = adhesion tension
$S$ = surface tension
$\theta$ = contact angle $> 0$
Subscript 1 = solid
Subscript 2 = liquid

This device is useful where the contact angle is finite, but for the purpose of a study of adhesives it is much more important to measure the attraction of a solid for liquids which form a contact angle of zero. In other words, the best adhesion is given by substances which have a greater adhesive



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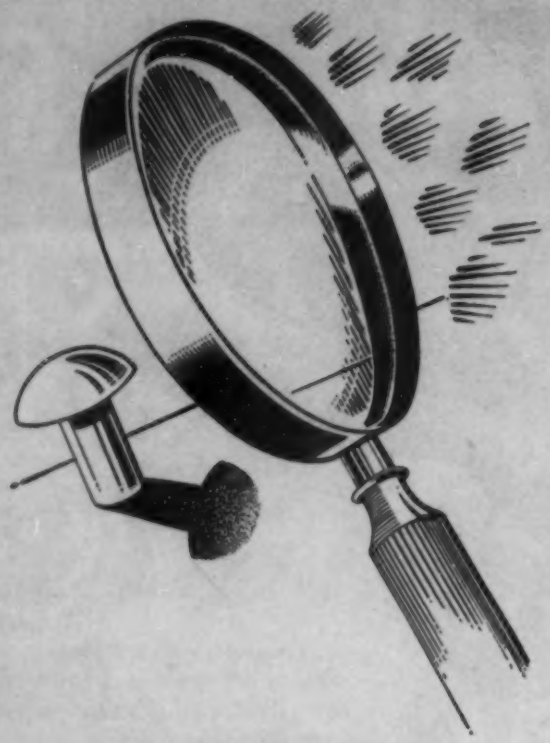

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attraction for the surface than cobesive attraction within themselves.

Bartell and coworkers have found that by using two immiscible liquids, one which wets the surface very well and one which wets it very poorly, it is possible to measure adhesion tension if several other values are known or can be calculated. This is based on the use of a displacement cell now known as the Bartell cell which is shown in Fig. 5.

The solid substance is powdered to a uniform particle size, carefully cleaned and dried and packed into the cell compartment by a special technique, such that two-thirds of the plug is saturated with the poorly wetting liquid and one-third with the liquid which is to be measured. The spaces between the powdered particles behave like minute capillary pores, the average radius of which may be determined by means of the formula for the rise of liquids in capillary tubes as well as by Poiseuille's formula for the rate of flow of liquids through capillary tubes. Values calculated by both of these methods check the pore size with a high degree of accuracy.

After packing the cell, the equilibrium pressure required to displace the poorly wetting liquid by the highly wetting liquid is measured. By means of the following formulae the adhesion tension is calculated:

$$\cos \theta_{2,3} = \frac{981\ Pr}{2\ S_{2,3}} \qquad (2)$$

$$A_{1,2} - A_{1,3} = \cos \theta_{2,3}\ S_{2,3} \qquad (3)$$

$$A_{1,3} = \cos \theta_{1,3}\ S_3 \qquad (4)$$

$$A_{1,2} = \cos \theta_{2,3}\ S_{2,3} + A_{1,3} \qquad (5)$$

where:

$A$ = adhesion tension
$P$ = displacing pressure
$S$ = surface tension
$\theta$ = contact angle
$r$ = average pore radius
Subscript 1 = solid
Subscript 2 = highly wetting liquid
Subscript 3 = poorly wetting liquid

An example of such a calculation is given by solid carbon, carbon tetrachloride and water (carbon = 1, carbon tetrachloride = liquid 2; water = liquid 3):

$\theta_{1,2} = 0°$ $\qquad r = 9.3 \times 10^{-6}$ cm.
$\theta_{1,3} = 40°\ 35$ min. $\qquad P_{2,3} = 6935$ g./cm.$^2$
$S_{2,3} = 44.54$ dynes/cm. $\qquad S_3 = 72.08$ dynes/cm.

$$\cos \theta_{2,3} = \frac{6935 \times 981 \times 9.3 \times 10^{-6}}{2 \times 44.54} = 0.7103$$

$$A_{1,2} - A_{1,3} = (0.7103)(44.54) = 31.63 \text{ dynes/cm.}$$

Adhesion tension water:carbon $= A_{1,3} =$ (cos 40°35 min.) (72.08) = 54.74 dynes/cm.

Adhesion tension $CCl_4$:carbon $= A_{1,2} = 54.74 + 31.63 =$ 86.37 dynes/cm.

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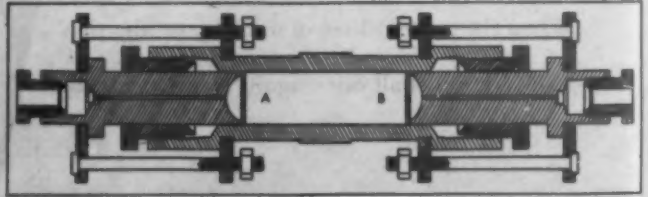


*5—The Bartell Cell. (From Bartell and Osterhof).*
*A. Section wet with highly wetting liquid.*
*B. Section wet with poorly wetting liquid*

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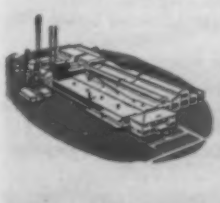

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*Heat of wetting*[32]—When a solid is immersed in a liquid it may or may not be dissolved, but in either event a heat change occurs. The heat liberated in the latter case is known as the heat of immersion or wetting and is directly related to the energy of attraction between the two substances. Harkins and coworkers have devised a calorimetric method for measuring this heat and the results have been applied in the paint and varnish industry in selecting suitable vehicles for pigment particles.

*Heat of formation*—In the investigation of the nature of adhesion, the heats of formation of chelate compounds as well as ion exchange reactions of certain groups such as hydroxyl and carbonyl should throw some light on the strength of bonds involving such groups. Phenolic resins remove anions from water by exchanging hydrogen for the anion on the hydroxyl group. This takes place readily with sodium and should bear some relation to the heat of reaction of sodium phenolate, resorcinate, etc. Although unmodified phenolic resins are poor adhesives for metals, because of incompatible physical properties, they do form such strong bonds to steel molds that the removal of a molded object may be effected only when waxes are used to prevent bond formation.

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N.A.C.A. Technical Note No. 989 contains a list of over 500 reports published by technical journals, aircraft manufacturers, adhesive manufacturers, and Government laboratories on the subject of adhesives. References are also cited for recent patents in this field issued in the United States, Canada, Australia, Great Britain, Belgium, France, Holland, Switzerland, Russia, Germany and Japan. A copy of the complete report can be obtained from the National Advisory Committee for Aeronautics, Washington, D. C.

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Both Solvent and Solute. Part I. Preliminary. The System: Benzene, Iodine-Charcoal," Trans. Chem. Soc. *119*, 454–460 (1921).

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# Agricultural residues

(*Continued from page 160*) and the same resin as used in the compositions shown in Table I. The resin content, however, was reduced from 47.2 percent to 35 percent, and the fiber content was increased from 50 to 62.25 percent. Molding conditions were the same as those for the compositions shown in Table I; i.e., a temperature of 320° F. and a pressure of 3000 p.s.i. were used. The results of physical tests on specimens molded from these compositions are given in Table II.

The results in Table II indicate the superior strength properties of the corncob composition. From a practical


**Directory listings for 1946 Modern Plastics Catalog**

An expanded listing of personnel and equipment of material manufacturers, molders, fabricators, low-pressure molders, extruders and laminators, is now being compiled for the 1946 MODERN PLASTICS CATALOG. If any of our readers who have entered any of these branches of the plastics industry wish to be included, we urge them to request a personnel questionnaire.

Complete listing blanks for the entire Directory of the Plastic Industry are also available. Listings include educational institutions, materials and chemicals, machinery, equipment and supplies, mold and model makers, consulting and testing laboratories, industrial designers, etc., as well as the above headings.

There is no cost nor obligation involved. Address Directory Department, Plastics Catalogue Corp., 122 E. 42nd St., New York 17, N. Y.

# WIRED FOR SERVICE—TO BORNEO

Long flights . . . on schedule! And of all factors involved, few are more vital than the efficient performance of a plane's electrical system. That's why many of the wires in aerial freighters, bombers, and fighters are doubly protected by tubing* made of VINYLITE plastics. In some locations the tubing is exposed to corrosive fumes and spray, and this plastic material is resistant to both. The tubing is widely used as conduits to protect wires where they are attached to the frames. Its high dielectric strength permits the thin-wall construction that saves space in crowded instrument assemblies.

*Made by Irvington Varnish & Insulator Company

In addition to electrical applications, however, tubing of VINYLITE plastics stands up remarkably as a conveyor of corrosive gases and liquids. Resistant to acids, denatured alcohol, alkalies, and most petroleum products, on airplanes it serves as battery drains — draws off sulfuric acid, and comes through with flying colors. Its resistance to wear and abrasion has made it a prime choice for the reduction of chatter and vibration in light, flexible shaftings. It has excellent aging properties; is flexible even at —70 deg. F.; and certain formulations do not support combustion.

Tubing of VINYLITE plastics is made in a range of standard lengths, diameters, colors, and wall thicknesses—and the variety of types permits the right selection for every purpose. Write Department 29-N for detailed information and the names of suppliers.

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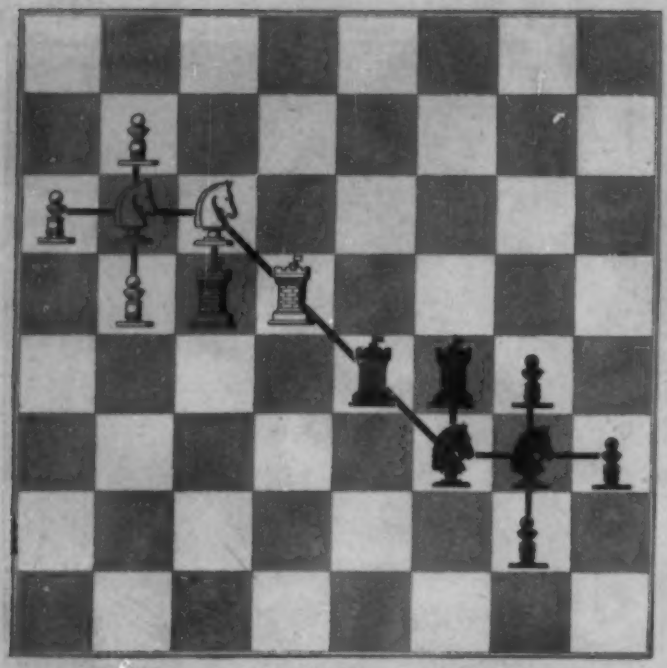

# This is not a game of skill ...IT'S BECCO ACETYL PEROXIDE

Perhaps chess was played before Brodie first began his investigations of Acetyl Peroxide in 1863; and certainly prior to a continuation of his studies by Vanino, Clover, Richmond, Gambarjan and Kharash. But its use was more risky than playing chess, for Kharash said of Acetyl Peroxide in the Journal of the American Chemical Society: "An outstanding peroxide of great usefulness but must be used on the spot (of manufacture) because of its sensitivity."

Chemists of the Buffalo Electro-Chemical Company, Inc., have developed a process for making solutions of acetyl peroxide which are perfectly safe to handle. It can, at present, be furnished in laboratory size samples only. It is a 30 percent solution of acetyl peroxide in dimethylphthalate, water white, non-explosive and immune to shock and impact.

Besides its value as a polymerization agent, other interesting applications include its use as a germicide, a bleaching and oxidizing agent, and in vulcanization. It has great possibilities in organic syntheses as it is very reactive and offers a source of active oxygen in a non-aqueous medium.

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point of view, the properties of the wheat straw composition were equal to those of the woodflour composition. Water absorption of the corncob and wheat-straw compositions was above that of the woodflour product. However, none of the compositions including that of woodflour met fully the A.S.T.M. specifications for general-purpose phenolics. All met some of the specifications and were only slightly deficient in those respects in which they failed to meet general-purpose specifications. The molding properties of these compositions were good, but conditions of compounding and molding were more critical than for compositions with higher resin content. Completeness of cure of standard water absorption test disks 1/8 in. thick, as estimated by resistance to water absorption and to cracking, was attained at about 2-min. molding under the temperature and pressure conditions used, i.e., 320° F. and 3000 p.s.i., which are conditions commonly used in commercial practice.

### Molding compositions of varied resin content

A series of compositions was prepared with flax-shive flour as the fibrous component and with resin contents of 55, 47, 35, 30 and 25 percent. The same resin was used as in the compositions shown in Tables I and II. The physical properties of specimens molded from these compositions are shown in Table IV. The temperature of molding of these specimens was 320° F. and the pressure was 3000 p.s.i.

The following general relationships may be deduced from the results in Table IV Under constant conditions of molding, flexural and tensile strengths decreased roughly in proportion to the reduction in resin content between 55 and 25 percent. However, the rate of decrease for flexural strength was greater than for tensile strength. Impact strength did not change appreciably with change in resin concentration, but the results show slightly higher values for resin concentrations below 35 percent. Milling and molding conditions became more critical when the resin concentration was reduced below 35 percent. The percent of water absorbed was found to be proportional to the product of the percent fiber and the reciprocal of the percent resin in the compositions.

### Summary

1. Excellent molding compositions were prepared from agricultural-residue flours with the proper types of phenol-formaldehyde resin. Several residue compositions yielded molded products which had flexural and tensile properties not only well above A.S.T.M. specifications for general-purpose phenolics but also superior to those of woodflour compositions made with the same resin. The selection of the proper types of resin appears to be essential for optimum results with a given residue. A corncob composition prepared with a commercial dry resin gave outstanding flexural and tensile strengths.

2. Resistance to water absorption within A.S.T.M. limits was readily attainable with residue compositions of normal resin content. Several compositions containing less resin (35 percent) also developed resistances which were well within the specifications.

3. The method of fiber grinding affected the impact strength of the compositions.

4. The cause of cracking on alternate wetting and drying of the compositions containing lignocellulose has been traced as due mainly to the water-soluble compounds in the resin constituents. Removal of these water solubles by washing of dry resins or by precipitation of liquid resins followed by washing, was shown to increase resistance to cracking greatly.

*(Please turn to next page)*

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5. The agricultural-residue compositions were prepared by the usual techniques and equipment used by industry and possessed flow and molding characteristics which adapt them to commercial use.

6. Compositions prepared with 35 percent resin and with 62.5 percent fiber showed molding and physical properties satisfactory for many uses.

7. Compositions containing 25 percent resin and 72.5 percent residue flour could be molded. However, the physical properties of the products were inferior and molding conditions were probably too critical for industrial use.

## Battery separator

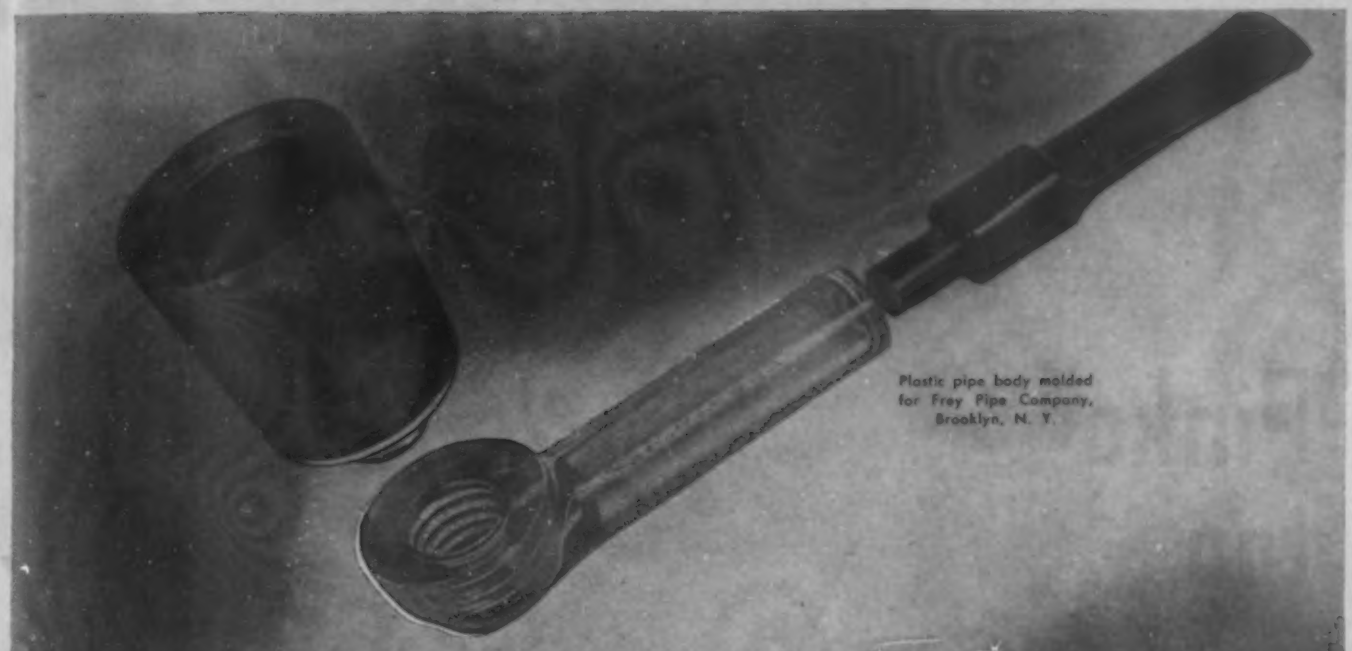
(*Continued from page 150*) nated glass mat then passes over a suction system where excess resin is removed. This leaves a variable resin content which is controlled by the number of inches of vacuum in the suction system. It is just after this operation that black lines are marked on the mats by a series of dye applicators placed over the expander-conveyor. These lines indicate the direction in which the separators must be inserted in the batteries.

After the dye is applied, the mat moves to a second conveyor which runs through a 140-ft. oven heated by hot currents of partially recirculated air. The temperature of the air is regulated by six thermostatically controlled heaters, each heating unit being individually controlled so that a gradual but complete cure of the resin is attained when the rate of the oven-conveyor is correlated with the unit-temperatures. The cured mat is then passed through multiple die cutting equipment where the finished separators are cut to the specified dimensions. As the separators leave the cutters, they move to the inspection and packing line for final inspection.

The square cornered separators, as offered to the United States Ordnance Department, are 0.065 in. thick, $5^{33}/_{37}$ in. high and $5^{7}/_{8}$ in. wide. Phenol-formaldehyde was selected as the binder because of its high acid resistance when fully cured, because it wets and bonds well with the glass fibers, and because it does not build up the internal resistance in the battery. Phenolic gives a stiff separator which simplifies assembly work, yet facilitates handling in a water solution.

The need for a battery separator of this type arose within three months after Pearl Harbor when the Japanese overran countries upon which the world had depended for 95 percent of its raw rubber supplies. To conserve as much of our rubber stock pile as possible, the Government asked that a substitute be found for the rubber storage battery separators which were being produced at the rate of about 15 million a month for the Armed Forces. Through the cooperation of leading battery companies and manufacturers of battery separators and retainers and like units, a satisfactory glass fiber separator was developed early in 1944 which was accepted by the automotive branch of Ordnance in Detroit and by battery manufacturers. In its final form the spearator has no ribs as do most other separators. It possesses great porosity especially horizontally and, when in close contact with the positive plates, acts like a retainer—holding back the active materials.

While the Catalin and Durez impregnated glass floss mats are cut to a small size for use as separators, this type of material when produced for plastic reinforcement and other applications can be turned out in continuous rolls up to 50 ft. in width and 300 ft. in length. The mats promise to be particularly popular for decorative applications where fire resistance is of importance—as in the theater. A method has been worked out of dyeing the glass floss mat in a resinous bath.



Plastic pipe body molded for Frey Pipe Company, Brooklyn, N. Y.

# a PIPE dream comes true...in Plastic!

At times, even the best behaved briar becomes balky! It is no easy job to turn out a one-piece bowl and body. Flaws develop. Rejects run high. The craftsman's patience is sorely tried!

By assembling *plastic* with briar, one pipe maker has found the answer to his problem. The separate plastic body, shown above, is Consolidated's contribution to the solution.

The bodies are injection-molded of acetate—in solid or transparent colors. The internal threads, held to close tolerance, are molded-in automatically. The pipe manufacturer, by a simple assembly, affixes the briar bowl and selected bit to the plastic body—thus does the pipe maker's dream come true—in easy-to-clean, non-tasting, non-odorous, appealingly colorful *plastic!*

Consolidated welcomes this opportunity to work with those who are now projecting peacetime products. Inquiries invited from all whose plans are now in the thinking-out stage.

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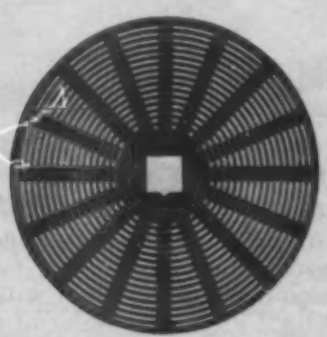
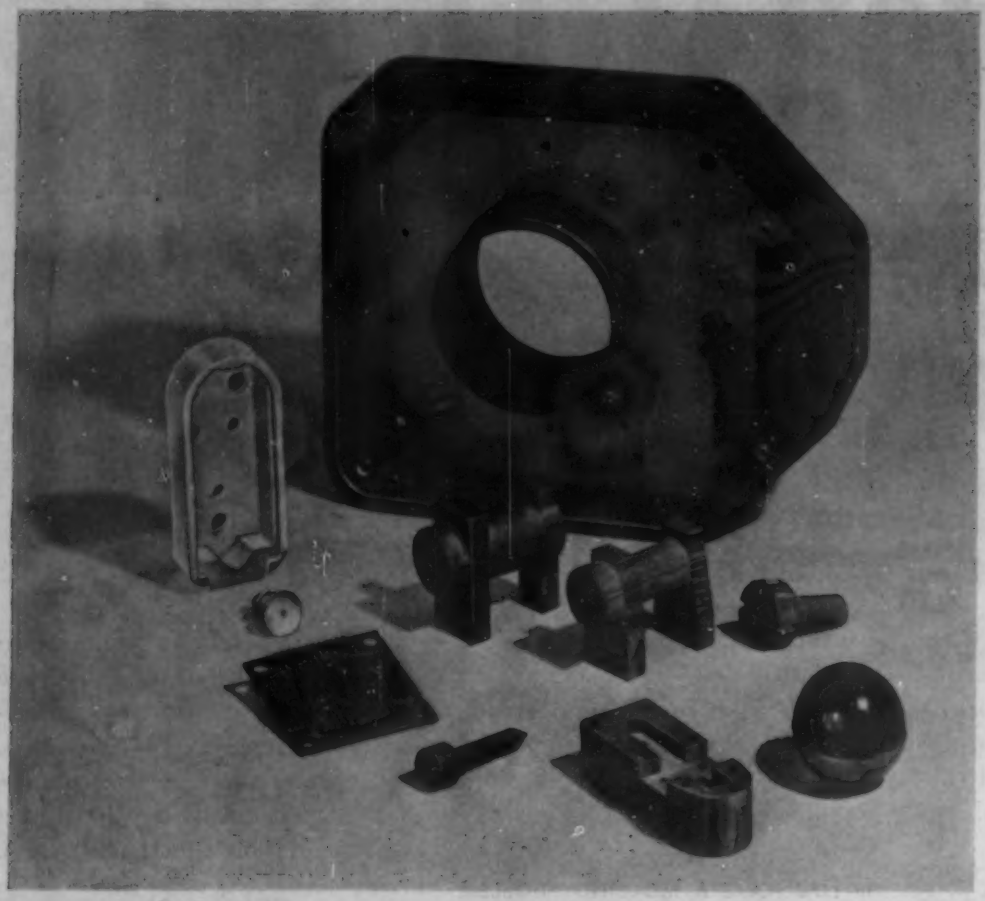


▪ *Intricate Aerojet Reel molded of Makalot No. 1804 by the Tech-Art Plastics Corp. of Long Island City, New York. Note the free-flowing, dimensional tolerances and fine finish.*

▪ *This terminal block, self-locking on snap-in contacts, holds them so firmly that they require manual release by means of a lever. The block withstands a 3000 V a.c. insulation breakdown test—hence impact strength was of great importance. Makalot No. 66-E was used for the body of the Terminal Strip and Makalot No. 2804 for the levers. Block was molded by Plas-Tex Corporation, Los Angeles, California.*



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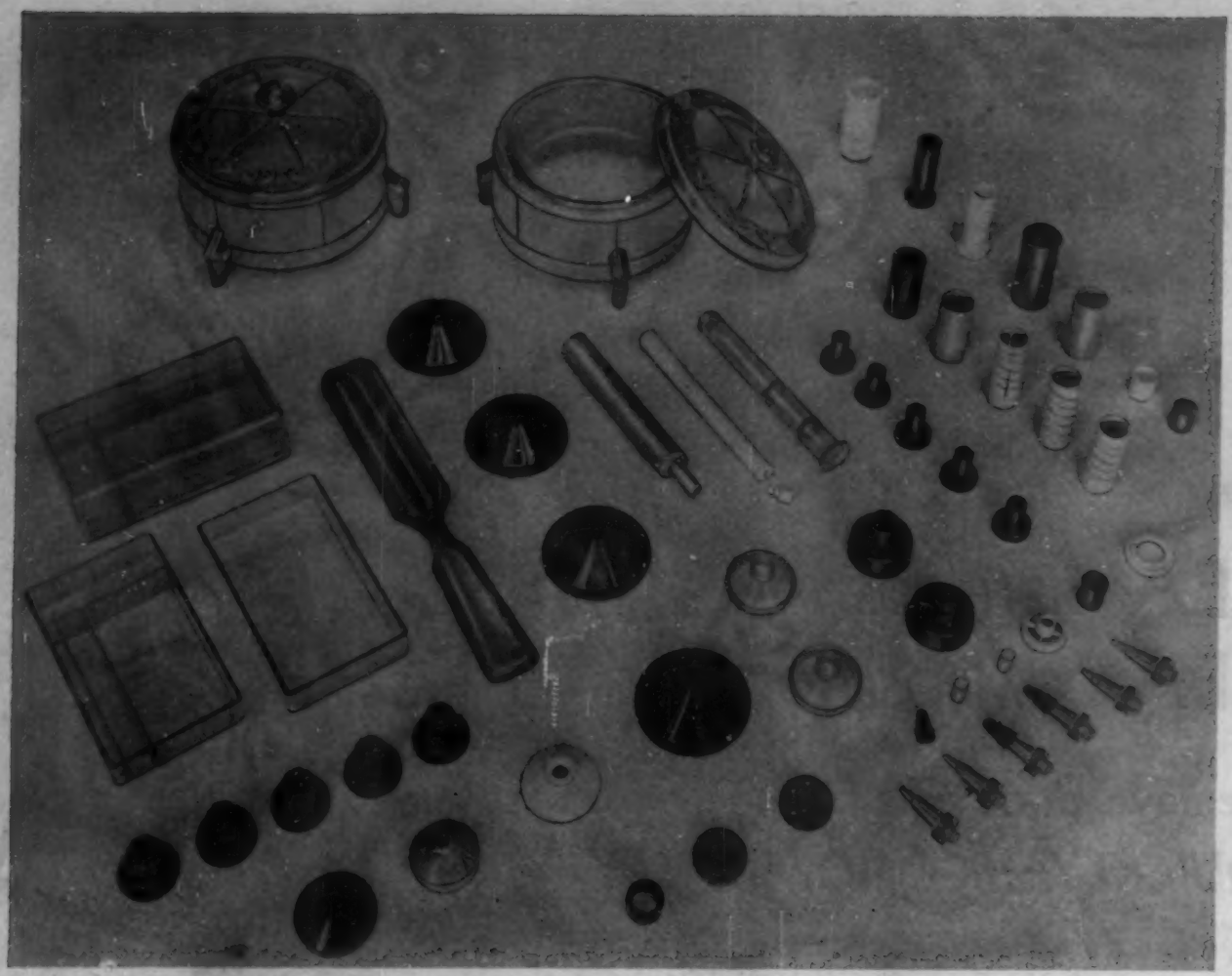

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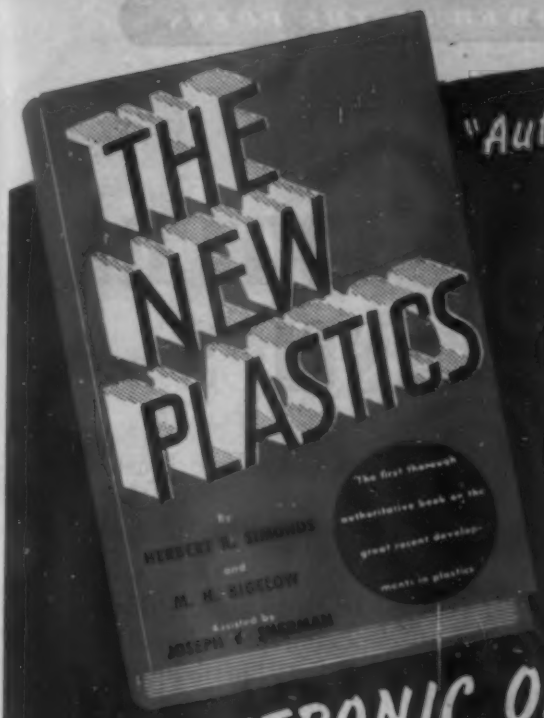


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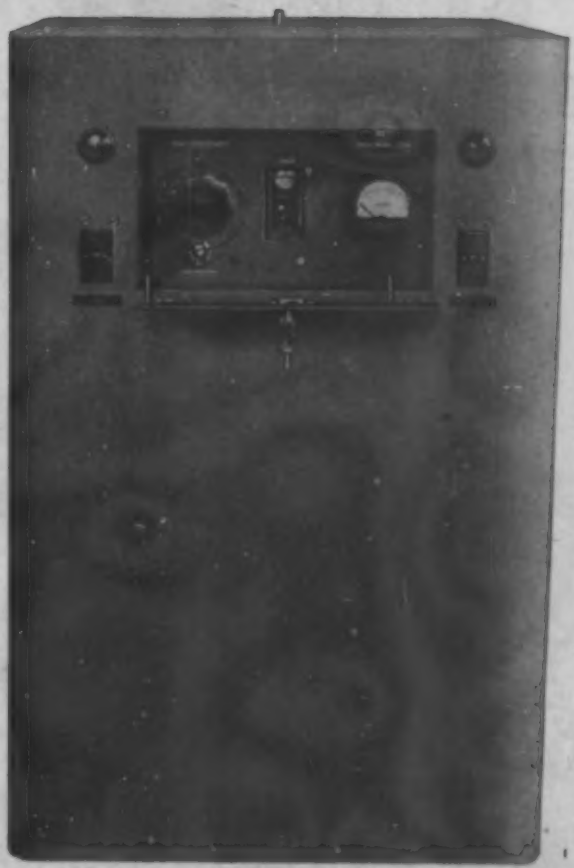

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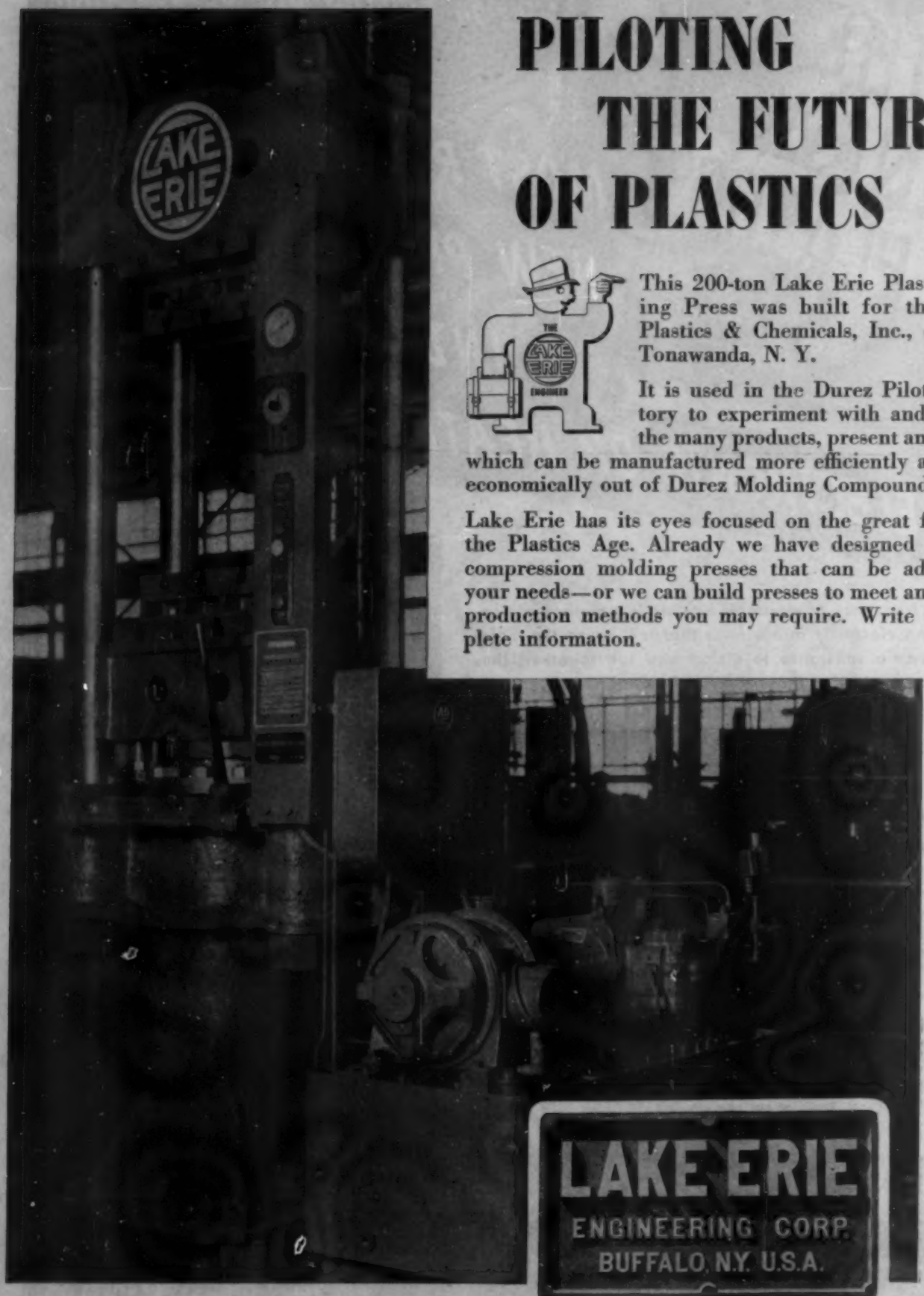
It is used in the Durez Pilot Laboratory to experiment with and test out the many products, present and future, which can be manufactured more efficiently and more economically out of Durez Molding Compounds.

Lake Erie has its eyes focused on the great future of the Plastics Age. Already we have designed standard compression molding presses that can be adapted to your needs—or we can build presses to meet any special production methods you may require. Write for complete information.



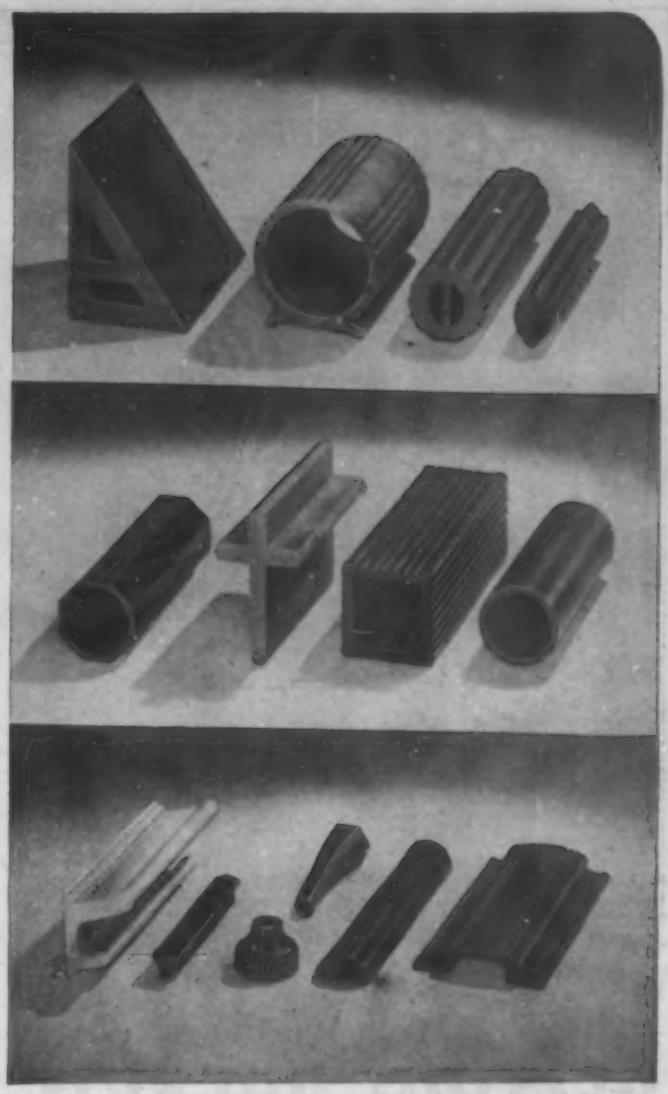

LAKE ERIE ENGINEERING CORP.
868 Kenmore Station, Buffalo 17, N.Y.

# MARBLETTE

THE *Versatile* PLASTIC

## A CAST PHENOLIC RESIN OF EXCEPTIONAL QUALITIES

- Outstanding among plastics, Marblette has a jewel-like depth and a complete color range which duplicates the appearance of precious stones, tortoise shell and ivory.
- Its almost infinite variety of colors is available in transparent, translucent, opaque, or in mottled effects. Marblette also comes in a waterclear form known as "Crystle" in a wide choice of colors.
- Marblette's machining characteristics, resistance to oil and acids, non-inflammability and exciting beauty make it ideal for countless manufacturing needs.



*A few of the many types of Special Marblette castings made to customer's specifications.*

## SPECIAL CASTINGS

Marblette is supplied in sheets, rods, tubes, and special castings such as cutlery handles, kitchen utensil handles, pipe stems, cigarette holders, clock cases, automotive trimmings, jewelry items, buckles, etc. Special shapes made to customer's specifications can be supplied provided draft is all one way.

## MARBLETTE LIQUID PHENOLIC RESINS

**Casting Resins for Forming Dies and Tools**

**Metal Casting Sealing Resins**

**Bonding Resins**

**Low Pressure Laminating Resin**

**Bristle Setting Cement**

**Laminating and Insulating Varnish**

**Clear Phenolic Lacquer**

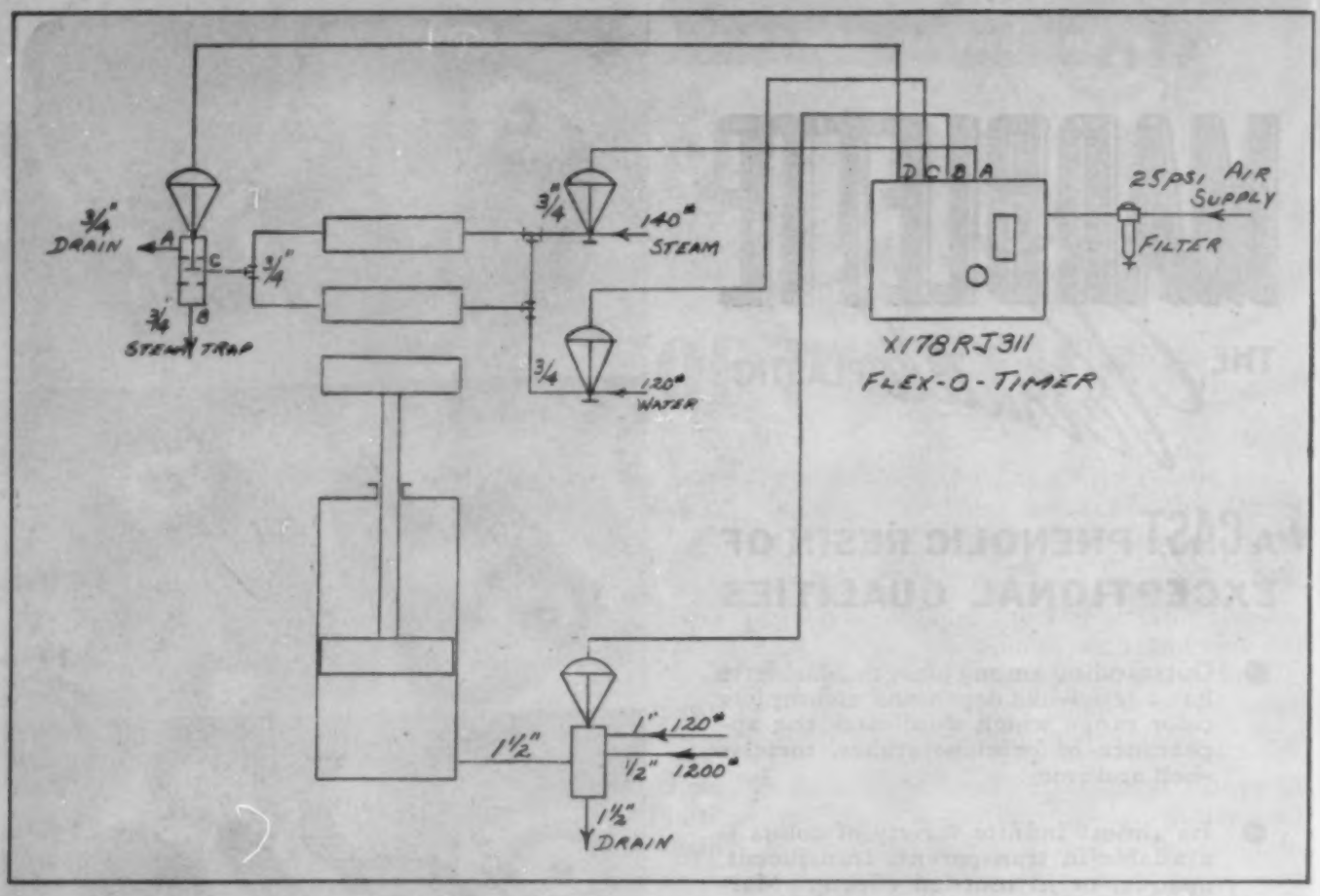
## MARBLETTE WILL HELP PLAN YOUR WORLD OF TOMORROW

The Marblette staff of engineers offers its services to help with your manufacturing problems. Write to us outlining your needs.

**THE MARBLETTE CORPORATION**

*Manufacturers of Phenolic Resins Since 1928*

57-21 Thirtieth St., Long Island City 1, N. Y.




# *We call this our*

# RECORD-BREAKING RECORD-MAKER

TO put it another way, this Taylor control setup for a phonograph-record molding press ought to break all records making records. And *not* break 'em either, if you know what we mean.

As far as we know, it's the first time that complete automatic control has been applied to the molding of transcriptions. Watchdog over the whole operation is the Taylor Flex-O-Timer. Here's what happens:

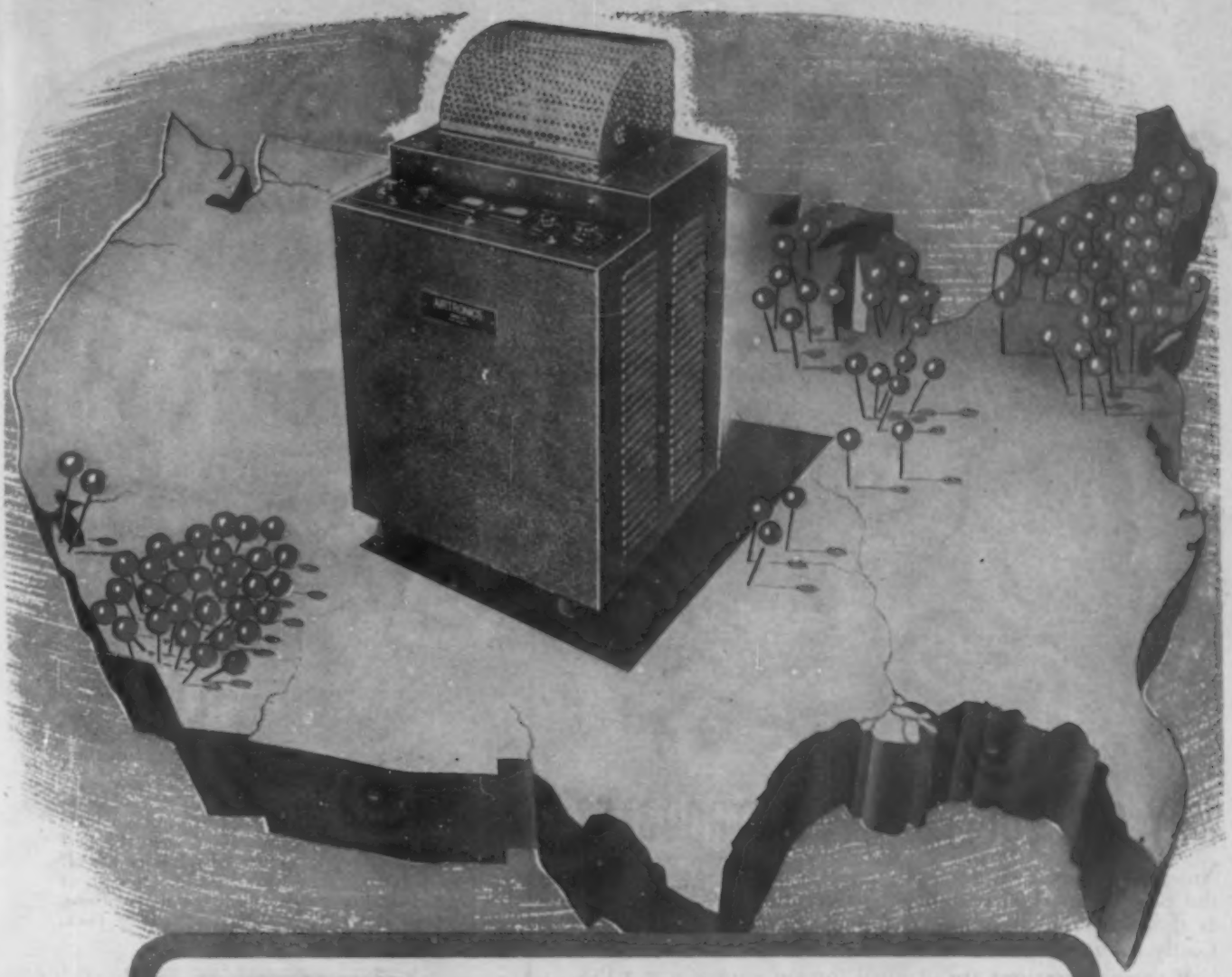
1. **Flex-O-Timer simultaneously;**
   (a) *closes press,*
   (b) *turns on steam,*
   (c) *positions three-way valve to connect discharge to steam trap.*
2. **Next the Flex-O-Timer simultaneously;**
   (a) *turns steam off,*
   (b) *turns water on,*
   (c) *repositions three-way valve connecting discharge to drain.*
3. **At end of molding period, the Flex-O-Timer;**
   (a) *opens the press,*
   (b) *turns cooling water off,*
   (c) *turns on steam for warm-up for next cycle,*
   (d) *positions three-way valve to connect discharge to steam trap,*
   (e) *turns steam off and timer stops.*

Ask your Taylor Field Engineer or write today for Catalog No. 98154. Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada. *Instruments for indicating, recording, and controlling temperature, pressure, humidity, flow and liquid level.*

*Buy Victory Bonds and Keep Them!*

ARMY ★ E ★ NAVY

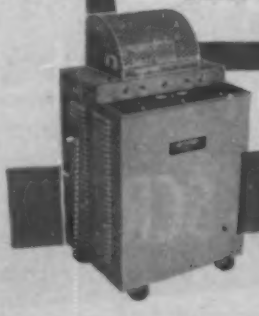
*Taylor Instruments*
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY



# More and More Leading Molders Specify AIRTRONICS

Today, from coast to coast, AIRTRONICS Preheaters are serving the leaders of the plastics molding industry. Part of the story behind this nationwide acceptance lies in AIRTRONICS' unique design features, such as Automatic Tuning, Dual Load Selection, and Automatic Power Regulation which bring to molders the *practical* means of obtaining *all* of the production advantages of electronic preheating.

The rest of the story lies in the competent technical advice and prompt service available to all users. You are invited to contact the AIRTRONICS sales-engineer in your area for advice on your particular preheating problem. There is no obligation.



Airtronics MANUFACTURING CO.

| LOS ANGELES | CHICAGO | NEW YORK |
|---|---|---|
| 5245 W. San Fernando Rd. | 407 S. Dearborn | 31-28 Queens Blvd. |
| Zone 26 | Zone 5 | Long Island City |
| | | Zone 1 |

# Here's the place to "Blitz" your Fastening "Bugs"

## WHY GET TOOLED UP FOR TROUBLE?

Now, while you are designing or redesigning products for the postwar market, is the time to question every fastening. Is there any needless tapping? Avoidable bolt assembly? Costly inserts in plastics? Riveting in hard to reach places?

If these operations are planned for any spot where a P-K Self-tapping Screw could be used, you are tooling up for trouble–slowdowns that will show up soon in the cost records.

A switch to the short cut fastening method – with P-K Self-tapping Screws – often saves from 30% to 50% in assembly time and labor. Find out now how P-K Screws can give your product this cost advantage against competition!

### HOOVER GETS A BETTER PLASTIC FASTENING . . . AND SAVES MONEY

When engineers in the Hoover Company sought the best, most secure assembly method – they found the answer in P-K Type "Z" Self-tapping Screws. They got the simplest, cheapest method, too. In addition to joining molded bearing head and molded motor case, Hoover used these Screws to secure fiber insulator in motor plug and to attach various metal and molded units to molded parts.

## PUT YOUR PLANS THROUGH THE "PAR-KA-SCOPE"

LENS of the "Par-Ka-Scope" is the eagle eye of a P-K Assembly Engineer. He can help you focus on the fastening "bugs" that usually hide out until you are all set up for production, then start running up costs.

Whatever they are he'll help you find them now, when a changeover requires only a little pencil work. He'll recommend only the best Self-tapping Screw for the job – P-K makes *all* types. Tell us when you'd like him to call, or send assembly details for recommendations. Parker-Kalon Corp., 208 Varick St., New York, 14, New York.

**GET THIS GUIDE – IT'S FREE.** The P-K "Users' Guide" describes all types of P-K Self-tapping Screws, tells where and how to use them . . . information every designer and assembly planner needs. Write for it.

# PARKER-KALON
## Quality-Controlled
## SELF-TAPPING SCREWS

For Every Metal and Plastic Assembly

# OLSEN-BAKELITE

# PLASTIC FLOW TESTER

## The Recognized Standard for Laboratory Testing and Production Control

The Olsen-Bakelite Flow Tester was developed for use on thermo-plastic and thermo-setting materials. It has found increasing usage in the plastics industry because of the wide variety of materials which fall in one or the other of these classifications — all of which must be accurately rated in order to assure uniformity and efficiency in production.

### What the Olsen-Bakelite Flow Tester Does:

1. Provides for controlling and varying the temperature as it is being applied to the material being tested.
2. Provides for application of pressure in units of 100 lbs. per square inch up to 3,000 lbs. per square inch.
3. Determines the plasticity properties while these changing conditions are taking place.
4. Assures an accurate means of observing and recording the results of such changes. For this purpose an automatic recording device is furnished.
5. Thus the machine plots the flow of the material against time.

If you have not already received your copy of Bulletin 23, giving details of the complete line of Olsen Plastics Testing Equipment, write today on your company letterhead and a copy will be sent to you by return mail.

*Proving every day that the value of testing depends on the quality of the testing equipment.*

**TINIUS OLSEN TESTING MACHINE CO.**
580 NORTH TWELFTH ST., PHILADELPHIA, 23, PA.
*Representatives: Pacific Scientific Co., Los Angeles, San Francisco, Seattle. Mine & Smelter Co., Denver, Colo.*

PHYSICAL TESTING EQUIPMENT • BALANCING MACHINES

# *Announcing the New*

## MODEL C *Milwaukee*

## AUTOMETRIC BORING MACHINE

Advanced in every detail the Model C Autometric Boring Machine offers initial high accuracy — design and construction to sustain this initial high accuracy throughout a long productive life — unexcelled simplicity, ease and convenience of operation.

Note these "shop-tested" features:

- Column, bed and chip guard cast in one sturdy unit — integral design.
- Rugged, compact, balanced construction with exceptionally low center of gravity — minimum vibration.
- Hardened, ground, and lapped quill, saddle and table ways — for sustained accuracy.
- Large diameter quill with extra long bearing, sliding in a fixed headstock, provides the total range of vertical movement — fewer moving parts.
- Direct measuring by Precision Screw Locating results in faster operation—with no loose pieces to handle
- Rapid traverse to spindle quill is instantly available — speed and ease of operation.
- Greater Speed and Feed Range — infinitely adjustable spindle speeds from 50 to 2500 rpm; 8 bo feeds .0005" to .0148" per revolution of spindle

Your precision boring costs can be reduced complete information on the Model C Mi Autometric — write for Catalog No. CMA1

**KEARNEY & TRECKER** *Products*

**CORPORATION** WISCONSIN

MILWAUKEE 14, Subsidiary of Kearney & Trecker Corporation

# WE ARE ON THE ALERT!

With World War No. 2 at an end, Northwest Plastics is away out in front in the manufacture of products for peace. During the past six months our Research and Engineering departments have been concentrating on improvement and development of plastics.

Here, at Northwest, new and original plastic products are rolling off our production lines. With the skill and experience of four years of precision molding for war, this Company now turns to the molding of tomorrow's plastics for peace.

Let a Northwest representative show you how this Company can assist you with your molding problems. Write today for complete information. Address Northwest Plastics, Inc., 2233 University Avenue, St. Paul 4, Minnesota.

ARMY ORDNANCE AWARD

FOR MERITORIOUS PRODUCTION

*Compression molding · Transfer molding · Injection molding · Extrusion molding*
*Modern Tool and Die Department · Finishing, Fabricating and Assembling Department*
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SOCIETY OF THE PLASTICS INDUSTRY SPI

NORTHWEST PLASTICS inc.

Here is the dependability that you get at **dura,** — reliability; uniform quality fulfilling your specifications; production by skilled and reliable craftsmen; delivery dates that you can depend and base your own schedules on. All this dependability, plus the fabricating know-how that comes from years of experience in all types of plastic fabrication, can be put to work for you. **dura** invites you to join the forward looking firms that depend on **"dura".**

**NOW IS THE TIME TO CONSULT DURA**

**dura plastics,** inc. 1 WEST 34 STREET, NEW YORK 1, N. Y.

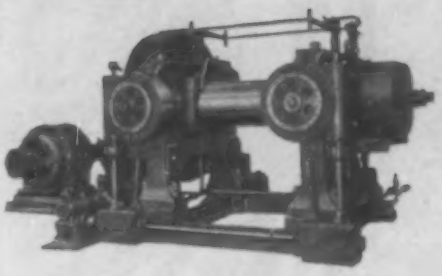
*Custom fabricating specialists to the aviation, electronic and shipbuilding industries.*

# F-B PLASTICS MACHINERY

## for cutting cost corners in processing

The day will return when production costs will again be of equal importance with "how many" and "when." To get your costs in line you will need modern machinery—machinery that has been designed specifically for handling plastics. Because Farrel-Birmingham machines are *designed for the job* of processing plastics, they will give you favorable answers to the questions of cost, quality and output.

BANBURY MIXERS produce mixes of exceptional uniformity and superior quality, with large savings in power, labor and other costs. The heat necessary for handling plastics can be maintained at constant temperature. A wide variety of materials, colors or formulas can be processed without difficulty. Dust and fume hazards are eliminated. Positive, automatic control of entire procedure is provided.



ROLL MILLS are designed for high temperature converting and mixing, and are provided with attachments and equipment to suit individual requirements. Chamber-bored rolls, fitted with special type stuffing boxes, are carried in water-cooled, flood-lubricated journal boxes. High strength materials provide the necessary ruggedness for heavy duty service. The rolls can be chrome-plated and the adjustable guides and mill pan made of non-corroding metals where required.

CALENDERS for sheeting and coating plastics are available with any number and arrangement of rolls, and fitted with attachments to suit their particular function. The calender shown here has individual motors for each screw of the top, bottom and side rolls. This makes possible independent or synchronized adjustment of roll ends for close control of gauge. Rolls are chamber-bored for steam circulation. Many other features also contribute to efficient operation and product quality.

*Write for further information about any of the machines shown or listed on this page.*

**FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.**

Plants: Ansonia, Derby and Stonington, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles, Tulsa, Houston, Charlotte

FB-240

**F-B PLASTICS MACHINERY**

Banbury Internal Mixers — Roll Mills
Converting, Mixing and Sheeting Rolls
Calenders — Extruding Machines
Hydraulic Presses — Hydraulic Accumulators
Sheet Cutters or Planers

Farrel-Birmingham

# New!

## Plastic Transfer PRESS

*There's nothing like the New Defiance Transfer Press!*

*Designed by plastics engineers for the plastics industry*... this new Press offers higher accuracy in production... lower die designing and construction costs... reduction of waste material... lower maintenance costs... and greater cleanliness.

In the Defiance Transfer Press a transfer pot and punch are *furnished with the press*... thus eliminating the necessity of designing these units with the die. Other pots and punches are available and easily changed.

The Defiance Press is ruggedly built with extra strength in vital parts. *Overall die support reduces die distortion* to the minimum.

Floating die support provides more loading space and makes pot more accessible. Electrically heated punch affords close control of cull set-up. Double action permits use of smaller pots, thus *reducing wash* and waste material and insuring *more uniform cure* of material.

Write for bulletins detailing the many new advantages of the Defiance No. 152 Transfer Press. Defiance Machine Works, Inc., Defiance, Ohio.

**NEW BULLETINS**—*Write for latest bulletins on the New No. 152 Plastic Transfer Molding Press; also, bulletins on Defiance greatly advanced Preforming Presses.*

# DEFIANCE

**Backed by 95 Years of Precision Manufacture**

# The shortest distance between two points is a PLASTIC CURVE

We don't want to be too technical, but modern industry has proved plastics to be a real short cut to many complicated production problems.

The Plastic Division of The Standard Products Co. is one of the largest molders of plastics in the United States. Standard's large molding plant is equipped with the most modern molding machines. Three of the massive presses have an injection capacity of 36 ounces of material per press cycle.

Backed by years of experience, Standard Products Plastic Division has acquired a wealth of knowledge in the art of molding plastics.

Standard engineers, chemists and co-workers will produce your molding job quickly and efficiently at moderate cost. No matter how complicated the molding job may be, Standard can do it better.

If you have a difficult molding problem, let us have the necessary data and our engineers will submit designs and proposals. Inquiries solicited.

## THE STANDARD PRODUCTS COMPANY

**Administrative and Sales Offices**

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1855

## Saturating Papers for PLASTICS

W.G.P. furnishes Sulphate or Cotton base saturating papers for the impregnation of thermoplastic and thermosetting types of resins in fluid form. We can also furnish light weight cotton paper to be used as a surfacing or print sheet. Manufacturers of leather substitutes in the luggage and shoe trades should investigate the unusual saturating qualities of our cotton sheet for the saturation of the various types of synthetic latex and resin emulsions.

*Sample sheets and rolls available in various thicknesses.*

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PAPER AND BOARD

*Make Plans Now . . .*
*for the coming* **PLASTIC ERA**

## *Consult* ROGAN

Here at Rogan, seasoned engineers are ready and willing to assist you in determining your post-war *Plastic* requirements.

Whether your peacetime products are to include electronic equipment, electrical appliances, stoves or what have you, the Rogan Organization will gladly provide cost-free advice on all phases of plastic production.

*Send Us Your Specifications Today!*

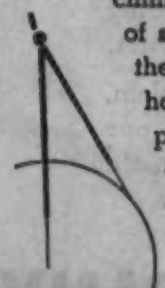
## ROGAN BROTHERS

*Compression Molders and Branders of Plastics*

2005 So. Michigan Avenue Chicago, Illinois

## FACTS YOU NEED TO KNOW ABOUT MOULDED PLASTICS

● Certain plastics withstand heat better than others. Some are particularly adapted for jobs that must withstand wear. Others are best for machining and threading. ● The secret of success in plastics is in knowing the right plastic to use for the job at hand. ● Ask us to help you see what plastics can do in your business. ● Just send photo, sample or specifications, and we'll tell you quickly if it can be made in moulded plastics.



## THE MAGNETIC PLASTICS CO.

1900 EUCLID BUILDING • CLEVELAND 15, OHIO

## NOW IS THE TIME

to start post war planning and working on plastic molded parts Our engineers will be glad to call and discuss any problem having to do with compression or transfer molded parts.

RADIO CABINETS all sizes and other large housings are our specialty

All our molds are made by men with more than thirty years experience. Our engineers offer a similar background of experience. Combined, they guarantee production of highest quality, good looking moldings on the highest possible production basis.

CONSULTATION with our engineers is yours for the asking.

TRADE MARK

## Plastimold, INC.

ATTLEBORO, MASS.

# YOUR FUTURE LIES IN EXPORT!

- A healthy post-war business will be in large part an export business — are you prepared to take advantage of foreign markets?
- At no expense to you, we are in a position to promote and distribute your goods abroad, pay cash for your merchandise in the U. S.
- **WE RELIEVE YOU OF ALL RED TAPE ON SHIPPING SPACE, GOVERNMENT RESTRICTIONS, CREDIT RISKS, FOREIGN LANGUAGE COMPLEXITIES, AND DETAILS OF EXPORT DOCUMENTS AND SHIPPING.**

AMONG THE COUNTRIES IN WHICH WE ARE REPRESENTED:

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**PLAN YOUR ALLOTMENTS TODAY FOR POST-WAR SALES.**

*Detailed information will be promptly forwarded upon receipt of your inquiry without obligation.*

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## "RAYCOLITE"

This macerated fabric is bringing amazing economy to a wide variety of articles of the phenol-formaldehyde type. Let us familiarize you with its rapidly widening applications, as well as its cost-saving possibilities.

*Request Working Sample*

**Rayco Cotton Fillers**

**FILFLOC** Pure cotton flock of surprising cleanliness and uniformity.

**FABRIFIL** Macerated cotton fabric for extra strength.

**CORDFIL** Evenly cut lengths of tire cord for plastics of utmost strength.

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Fillers
RAYON PROCESSING CO. INC.
*Developers and Producers of Cotton Fillers for Plastics*

90 Tremont St., Central Falls, R. I.

WE BUY, SELL, PROCESS

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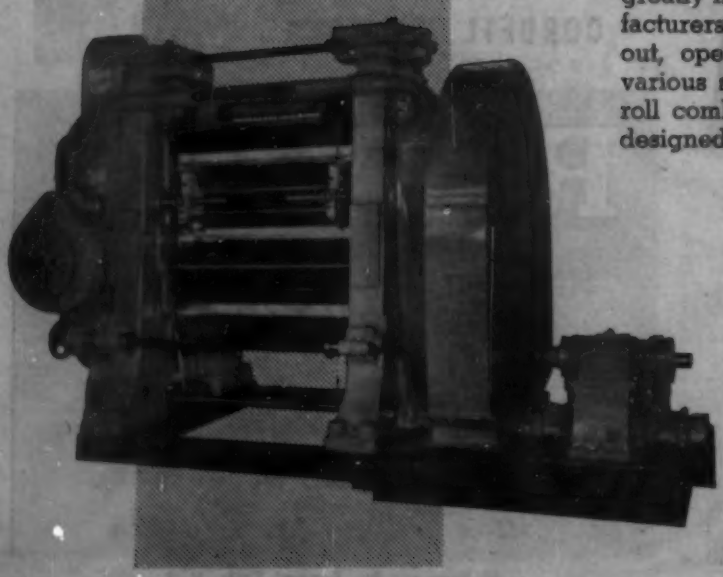
Thropp



## New Hi-Speed Calenders

THIS new Thropp 3-roll, high speed, heavy duty calender is one of a line of calenders designed to greatly increase production schedules for plastic manufacturers. These calenders are precision built throughout, operating quietly, and smoothly. They come in various sizes, both larger and smaller, and in varying roll combinations. All calenders are custom built and designed to meet customers specific requirements.

**Laboratory Mills and Calenders**

A new line of Thropp laboratory mills and calenders can now be equipped with GE Thy-Mo-Trol drive, providing wide speed range and close speed regulation from an AC source of supply.

**WM. R. THROPP & SONS CO.**
**Trenton, New Jersey**

Their Better FIT

Provides . . .

Faster Heat

Fewer Burnouts

WATLOW STRIP HEATING UNITS

will answer any exacting heating demands —from small intricate tasks up to heavy duty jobs. They are serving many production needs for heat—air heating, preheating, contact heat, dehydration, melting, curing and drying.

Watlow Electric Strip Heating Units in various forms and shapes are available in ¾" widths on up, and in lengths up to 72" and more,—and in capacities of 25 W to 4000 W and up—for circuits of 115 V to 440 V.

Efficiency, ease of control and long life are a few of the features you should investigate in Watlow Electric Heating Units.

*Write now about your production heating needs*

SPECIALISTS IN ELECTRIC HEATING UNITS

WATLOW

ELECTRIC MANUFACTURING COMPANY

1328 N. 23d St. St. Louis 6, Mo.

Let us tell you how you may use our organization just as if it were yours

A MOST UNUSUAL SERVICE TO A MANUFACTURER

YOUR REQUEST WILL BRING THE ANSWER (Reading Time 3 Minutes)

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MOLDINGS OF MERIT

*Compression Transfer Injection*

WATERBURY COMPANIES, INC.

FORMERLY WATERBURY BUTTON CO., EST. 1812

DEPT. B, WATERBURY, CONNECTICUT

NO MORE CORROSION

in Shipment and Storage

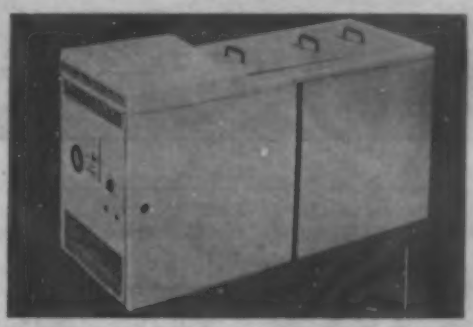
*Here's why:* Metal parts can be completely protected from corrosion with coatings of ethylcellulose compounds or other plastics. Applied by dipping, the plastic forms a tight-fitting coating that offers full protection even from handling damage during overseas shipment and long-time storage. When the part is to be used, the coating is easily cut and peeled off.

SPARK PLUGS COATED WITH PLASTIC

*Here's how:* For top-quality coatings, use the YM Plasticoater, a self-contained unit with these outstanding features:

- ★ **ACCURATE AUTOMATIC TEMPERATURE CONTROL** of the heating oil jacket and the plastic.
- ★ **UNIFORM TEMPERATURE DISTRIBUTION**
- ★ **CONTINUOUS PLASTIC MOVEMENT,** to remove bubbles and prevent separation of the compounds.
- ★ **CONSTANT DIPPING SURFACE LEVEL.**
- ★ **AUTOMATIC TIME CLOCK** to provide for early morning preheating of plastic—no delay at beginning of working hours.

Plasticoaters are made in a range of sizes that will meet practically any hot-dipping requirements. Write for further information today.



THE YM PLASTICOATER

THE YOUNGSTOWN MILLER COMPANY

*A Subsidiary of Walter Kidde & Company, Inc.*

1045 Kidde Ave. BELLEVILLE 9, NEW JERSEY

# FILLERS

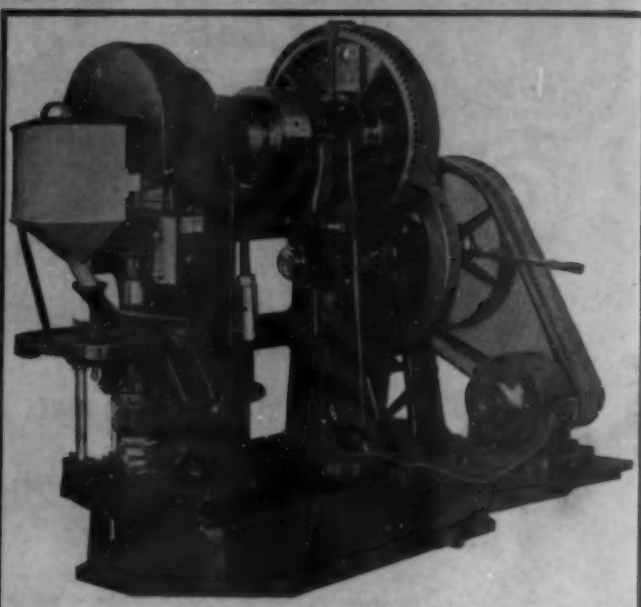
WOOD FLOUR
COTTON FLOCK
and FABRICS
OF SUPERIOR QUALITY
FOR THE

## PLASTIC INDUSTRY

LARGEST DOMESTIC SUPPLIERS

BECKER, MOORE & CO., INC.
NORTH TONAWANDA, N. Y.





## COLTON PREFORMER

THE new improved 5½ Tablet machine is the finest the market has to offer, solid steel frame, improved die fasteners and cam construction, vanadium steel plungers, etc. Write for catalogue..

**ARTHUR COLTON CO.**
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## DECORATORS ON GLASS AND PLASTIC CONTAINERS SINCE 1936

4 colors in 1 operation
—finest detail

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# SCREWS

All kinds, sizes and shapes, standard and special designs. Contract and engineered screw specialties, precision made, economically produced.

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KEENE, NEW HAMPSHIRE

SHEET METAL SCREWS MACHINE SCREW NUTS
MACHINE SCREWS PLASTIC INSETS
HOLDING PINS SPECIAL RIVETS
ALL TYPES OF HEADS AND THREADS

# Your Plastics Molding Problem Is Right Down Our Alley

Not that we can always make a strike, but our score for a good many years shows that we really know the game. We have an experienced designing staff that can help you with designs that are practical in plastics. We have expert mold-makers, one of the most important factors in the production of plastic pieces. Our molders know how to produce the most intricate part from every type of plastic material. A conference with us NOW may smooth the way for your post-war product.

ESTABLISHED 1919 — TRADE MARK

## KUHN & JACOB MOLDING & TOOL CO.

1200 SOUTHARD STREET, TRENTON 8, N. J.
TELEPHONE TRENTON 5391

*Plastic Molding*

Sales Representatives: NEW YORK—S. C. Ullman, 55 W. 42nd St. PHILADELPHIA—Towle & Son Co., 18 W. Chelton Ave. Bldg.
NEW ENGLAND—Wm. T. Wyler, 204 Lordship Road, Stratford, Conn.

# Original Model Making

GOOD REPRODUCTIONS DEPEND ON THE MODEL

Our skilled, professional model makers, master craftsmen, create and carve original models, perfect in all detail, for the type of reproduction desired.

RATES REASONABLE

*32 Pages . . . 420 Pictures . . . an Exhibit of Performance*
*Write for a copy of it Today on your business letterhead*

AMERICA'S LARGEST ORGANIZATION SPECIALIZING IN MERCHANDISE PRESENTATION

**W. L. STENSGAARD AND ASSOCIATES, INC.**

346 N. JUSTINE ST. • CHICAGO 7, ILLINOIS

## HOW MISKELLA INFRA-RED OVENS AND APPLIANCES SERVE THE PLASTIC INDUSTRY

| Branch of the Industry | Name of Appliance | Use |
|---|---|---|
| *Molders* (Thermo-setting) Compression | PELLET-VEYOR (Variable heat) | To preheat pellets and preforms at the press as needed |
| *Molders* (Thermo-plastic) Injection | VIBRA-VEYOR (Variable heat) | To preheat plastic powder automatically. To dry plastic powder automatically |
| Injection | HOPPER-HEATER (Variable heat) | To warm up heavy metal of hopper of molding machine |
| *Molders* (Thermo-plastic) Extrusion | STRIP-HEATER (Variable heat) | To preheat strip rolls of vinylite, etc., automatically as fed to worm |
| Material Manufacturers | Special production equipment including vibrators, conveyors, stainless steel belts and electronic devices | To process various kinds of plastic material in bulk |
| Fabricators (Miscellaneous) | BENCH-KIT In various sizes (Variable heat) | To soften sheets, rods, tubes and any shape for bending, forming, punching, etc. This includes Cellulose, Acetate, Methyl Methacrylate |

(The time on most of the operations mentioned above averages five minutes)
We sell lamps and build completely engineered infra-red equipment and appliance installations.

*Drying, Baking, Processing and Preheating Specialties*

**INFRA-RED ENGINEERS & DESIGNERS**

MANUFACTURERS
Main Office and Laboratory
1637 East Fortieth Street, Cleveland, Ohio

------A Picture of a man who knows
PLASTIC MOLDING

M. M. Martindell

Yes, it's a picture of Martindell's character as shown by his thumb print—the print of a man who has spent his entire business life, working in cooperation with a staff of experts, in solving problems of molding procedure from design to finished piece.

Are you in doubt as to whether your design is practicable for the molding process? Are you undecided which plastic material you should use? The solution is easy—ASK MARTINDELL. His organization has the answer.

MARTINDELL MOLDING COMPANY
Plastics PHENOLIC • UREA • CELLULOSE ACETATE MATERIALS
North Olden at Sixth
TRENTON 2, NEW JERSEY

WHO MAKES THE ATLAS Type "E"
High Pressure Reducing Valve?

This remarkable valve, shown at the left, which reduces pressures up to and including 6000 lb. per sq. in. *without shock*—oil, water, or air—and which is now used by most of the large plastics plants, is made by a concern that has specialized in regulating valves exclusively for nearly a half century—The Atlas Valve Company.

THAT'S WHY

That's why Type "E" is so good. That's why every detail is modern in every respect. That's why the entire body is of forged steel. The internal metal parts are entirely of stainless steel. A formed packing of special material superior to leather is used which is immune to all fluids commonly used in hydraulic machinery. The pressure on the seat is balanced by a piston with the result that variations in high initial pressure have little effect on the reduced pressure.

Ask for complete information.

*For other ATLAS plastics plant products see the partial list in our ad in the January 1945 issue of MODERN PLASTICS*

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE
277 South Street, Newark 5, N. J.
Representatives in principal Cities

DIEMOLDING CORPORATION
Canastota, N. Y.

TRADE DM MARK

A complete and thoroughly equipped molding plant with an enviable record of performance for many of the largest users of molded parts, products, premiums and packages.

Call upon our engineers and designers for aid or advice in planning your molded parts.

Our Twenty-fifth Anniversary Year
DIEMOLDING CORPORATION

DO YOUR OPERATIONS INVOLVE

# Joining Rigid Plastics

## TO GLASS, METAL, WOOD, FABRIC, LEATHER OR OTHER PLASTICS?

Our research and Technical Staff is experienced in developing specialized adhesives for special applications, including the plastic field. They may help you to bond these joints with Miracle Adhesives *without the need for screws, clips or mechanical fasteners—and without heat.*

We can serve you best when you send full details to Research Department, Miracle Adhesives Corporation, 852 Clinton Avenue, Newark 8, New Jersey.

# MIRACLE ADHESIVES

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SINCE 1918

# PLASTIC MOLDS

HAND
AUTOMATIC
SEMI-AUTOMATIC
and EXTRUSION
to the LATEST METHODS

Designers and builders of all types of PLASTIC MOLDS.

Serving most of the leading molders of the country!

Our 1500-ton hydraulic Hobbing Press adds many advantages in obtaining lower mold costs.

Estimates on request.

# EAGLE

## TOOL & MACHINE CO.

37–39 Freeman St. Newark, N. J.

Phone: MARKET 3-1572
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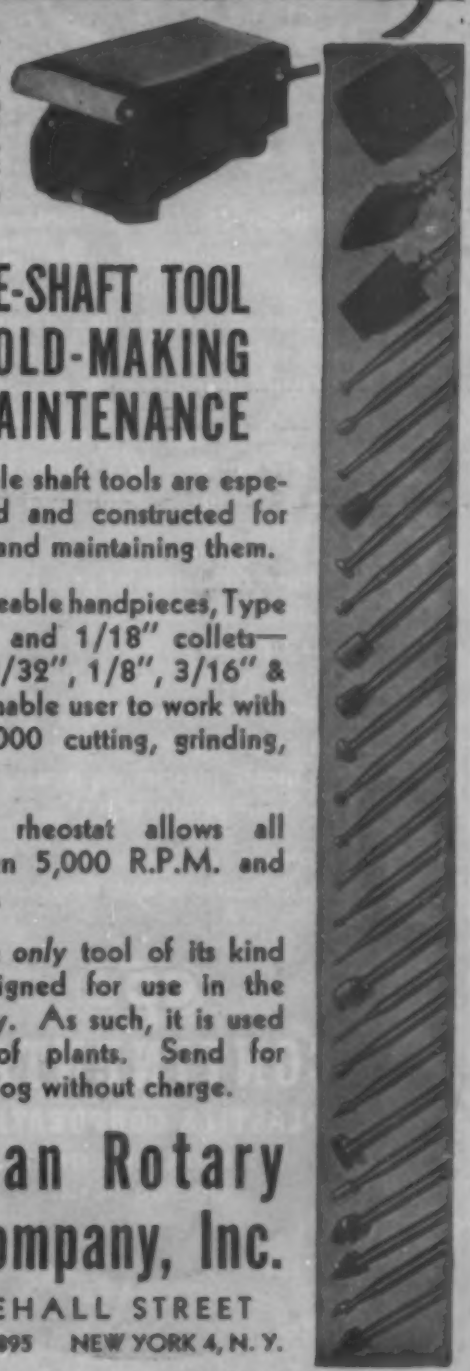

Unit F with K handpiece. 1/8 H.P., 20,000 R. P. M. Other Models from 1/20 H.P. to 1/5 H.P. and up to 22,000 R. P. M. 8 Different speeds, rheostat controlled.

# FLEXIBLE-SHAFT TOOL FOR MOLD-MAKING AND MAINTENANCE

ARTCO flexible shaft tools are especially designed and constructed for making molds and maintaining them.

Two interchangeable handpieces, Type K with 3/32" and 1/18" collets—Type H with 3/32", 1/8", 3/16" & 1/4" collets enable user to work with more than 1,000 cutting, grinding, polishing tips.

Foot-operated rheostat allows all speeds between 5,000 R.P.M. and 20,000 R.P.M.

ARTCO is the *only* tool of its kind especially designed for use in the plastics industry. As such, it is used in hundreds of plants. Send for Complete Catalog without charge.

# American Rotary Tools Company, Inc.

44 WHITEHALL STREET

BOwling Green 9-4895 NEW YORK 4, N. Y.

BEWARE
BEWARE
of the Big
"Plastics Rush"
• Today's buyers are looking for—demanding plastic products whenever possible. Countless manufacturers are in a frantic, last minute search for a reliable plastics designer and molder.
This is the time to turn to Continental Plastics Corporation and establish a permanent plastics connection.
Above the babel of plastics claims, the name Continental Plastics Corporation stands out for its record accomplishments. Here is the experience, engineering skill and facilities to insure plastics supremacy for your products.
Bring or send in your blueprints or sample products.
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# ELECTRONIC HEAT-SEALING FIXTURES

Fabricators of thermoplastic sheeting can simplify their production methods and reduce costs by using jigs designed and built by experienced engineers.

The Wilmotte organization consists of engineers with a successful record in the design of heat sealing equipment and electronic devices.

Let us advise you on the suitability of high frequency to your plastic sealing problems.

## WILMOTTE LABORATORY, Inc.

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## READY to INVEST with YOU up to $250,000

You may now have a small business but would like to expand to take advantage of post war business

or

You may be an executive, salesman or technician with excellent potentialities but handicapped for lack of capital.

We are ready to make you an attractive proposition if you have the experience and the "know how".

*Address your reply to, President*

**MUTUAL INDUSTRIES, INC.**

122 East 42nd St. New York

## LEADING SCRAP GRINDER USED BY EASTERN MOLDER

Photograph shows an installation of one of several Ball & Jewell scrap grinders in a leading Eastern molding plant. This molder relies exclusively on Ball & Jewell equipment to regrind his thermoplastic scrap into usable molding powders.

Model shown is #0, one of our smaller sized machines.

Ball & Jewell grinders are known throughout the entire plastics industry for their reliability. Each one is made with extra heavy castings to give it a greater margin of operating efficiency. All have solid tool steel knives, outboard S.K.F. bearings (sealed against dust) and three interchangeable screens for different sized granulations.

**BALL *and* JEWELL**

20 Franklin Street, BROOKLYN, N. Y.
Since 1895, Manufacturers of Patent Rotary Cutters

or get in touch with nearest representative

CHICAGO: Neff Kohlbusch & Bissel. DETROIT: J. C. Austerberry's Sons: LOS ANGELES: Moore Machinery Co. LOS ANGELES & SAN FRANCISCO: Machinery Sales Co. NEW ENGLAND: Standard Tool Co., Leominster, Mass. ATLANTA, GA.: George L. Berry. ST. LOUIS: Lanmore Sales Co. SEATTLE 4, WASHINGTON: Olympic Supply Co. KANSAS CITY, KANS.: Fluid Air Engineering Co. AUSTRALIA and NEW ZEALAND: Scott & Holladay Pty., Ltd., SYDNEY STOCKHOLM, SWEDEN: Ingenjorsfirman Teknova. CANADA: Williams & Wilson, Ltd., Toronto & Montreal, Canada HAWAIIAN ISLANDS: Hawaiian Sales Service, P. O. Box 3498, Honolulu 11, T. H.

This is #10 in a series of advertisements showing typical Ball & Jewell installations in molding, extruding and material manufacturing plants.

## TRICRESYL PHOSPHATE

Now fully available for prompt shipment without allocation.

*Manufactured by*

**MONTROSE CHEMICAL COMPANY**
120 Lister Ave. Newark, N. J.

**R.W. GREEFF & CO.**
10 ROCKEFELLER PLAZA NEW YORK CITY
TRIBUNE TOWER CHICAGO, ILL.

## GLYCERINE
*...quickly available*

**Armour's 332 stock points mean fast, dependable service**

**U. S. P....** A chemically-pure, water-white glycerine, meeting all requirements of the U. S. Pharmacopoeia . . . for use in foods, pharmaceuticals, cosmetics or any purpose demanding highest quality. Specific gravity, 1.249—25° C./25° C.

**HIGH GRAVITY...** A pale yellow industrial glycerine. Specific gravity, 1.262—15.5° C./15.5° C.

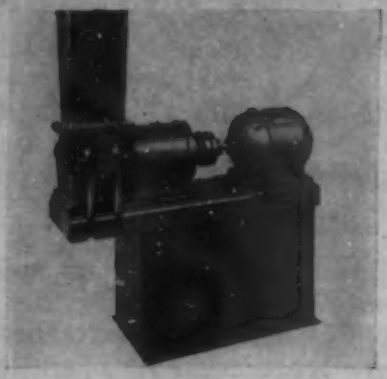
**DYNAMITE...** Made especially for the explosives trade. Specific gravity, 1.262—15.5° C./15.5° C.

**ARMOUR AND COMPANY**
1355 W. 31st St., Chicago 9, Illinois

# Cumberland Scrap Grinders

## Scrap granulating machines for every capacity requirement

Four Cumberland machines, built specifically for plastics, give a wide range of capacities. The #0 model is frequently used one per injection molding machine, so that the molding operator disposes of the sprues and runners as made. The #½ machine, illustrated here, has capacity for granulating the scrap from two or three molding machines. Larger sizes are the #1½ and the 18", which afford more capacity and grind material of large cross section.



**Cumberland machines have the following features:**

Ruggedness of construction.
Compact, efficient cutting chamber.
Ease of dismantling and cleaning.

***Request Complete Data***

**CUMBERLAND ENGINEERING CO.**

**Dept. A—Box 216, Providence, R. I.**

MEMO

COMPRESSION MOLDING is a job for experts

The jack-of-all-trades is rarely master of any one. We do compression molding—nothing else. And the customers we serve say we do it well. Have you a compression molding job which you want handled with particular skill? Get our suggestions and our estimate before you go ahead. Big jobs or small, they're all welcome. Write us today.

PLASTICS DIVISION
Allmetal Screw Products Company
80 Grand Street New York 13, N. Y.

"C.A."

"C.A." Grade pearl essence, specially developed for use with Cellulose Acetate moulding powder.

NON - YELLOWING

MEARLMAID PEARL ESSENCE

THE MEARL CORPORATION
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## ONE OUT OF MANY

There are several hundred molders of plastics in this country. We offer our services in competition with all of them on the basis of efficiency and economy. Our molding service works as an integral coordinated unit of your production.
Try us and see.

## KENILWORTH

PLASTICS MOLDING CO.
Dept. of Eureka Button Co.
KENILWORTH, NEW JERSEY

Branch Offices: I. L. Arkis Co., 43 E. Ohio St., Chicago 11, Ill.
Sabo-Gray Sales Organization 2970 W. Grand Blvd., Detroit 6, Mich.

## MODERN FRENCH OIL Presses for Molding Modern Plastics

● For accuracy, speed and economical operation that brings increased profits turn to French Oil Hydraulic Presses, the choice of leading plastic molders. Complete self-contained presses with automatic time control that is instantly adjustable. Dependable, modern French Oil presses in sizes up to 1500 tons are the choice of leading plastic molders. Consult French Oil engineers or write for catalog.

THE FRENCH OIL MILL MACHINERY CO.



## AT LAST!

A PERMANENT SURFACE DECORATING PROCESS FOR PLASTICS

Applies Your Name, Your Trade Mark, Your Decoration to Every Type of Plastics Molding. Widely used on containers and closures, perfect for novelties, jewelry, identification, tags, dials, name plates, etc. This process applies all colors integrally to *all* plastics. Special formulations for thermoplastic materials make it impossible to rub, wash or scratch off our imprinting.

Write or call for samples, prices, information.

Creative
PRINTMAKERS GROUP
14 West 17th Street New York CH 3-6803
Surface Decorators for the Plastics Industry

When your molds Must give

# LONG RUNS

LONGER runs, with flawless finishes, are often possible when you take advantage of Carpenter's long experience with mold steels.

In molding trench mortar fuse bodies, cavities and forces such as those shown here are made of Carpenter *No. 158* Mold Steel. The steel's extremely tough core and good wear resistance after carburizing made possible the long runs that were needed.

Drop us a line for help with your new or difficult mold-making problem. We will be glad to help you get the most from Carpenter's 100% acid-inspected mold steels. Put our experience to work on your problems. And meanwhile, be sure you have a copy of "Tooling Up for Plastics." It gets right down to the facts of selecting the proper mold steel for each job. A note on your company letterhead will start a copy on its way to you.

**THE CARPENTER STEEL COMPANY**

112 West Bern Street, Reading, Pa.

Carpenter DIOK

ELECTRIC FURNACE

MOLD STEELS

100% ACID DIE INSPECTED

EXTRUDED
PLASTIC
TAPE
FOR CONTINUOUS
PUNCH PRESS
FEEDING
Acetate
Vinyls
Styrenes
Acetate Butyrate
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Styraloy
For any type of punch press operation, NATIONAL can supply continuous strip stock, made to accurate dimensions, suitable for washers, gaskets and shapes of any kind, or for such purposes as forming, blowing, beading and general fabrication. Furnished in thicknesses up to ⅛-inch and widths up to 6 inches.
NATIONAL PLASTIC PRODUCTS Company
OGDENTON, MARYLAND



• ACRYLICS • CELLULOSE ACETATE • POLYSTYRENE • ETHYL CELLULOSE • VINYL RESINS •

Dealers in

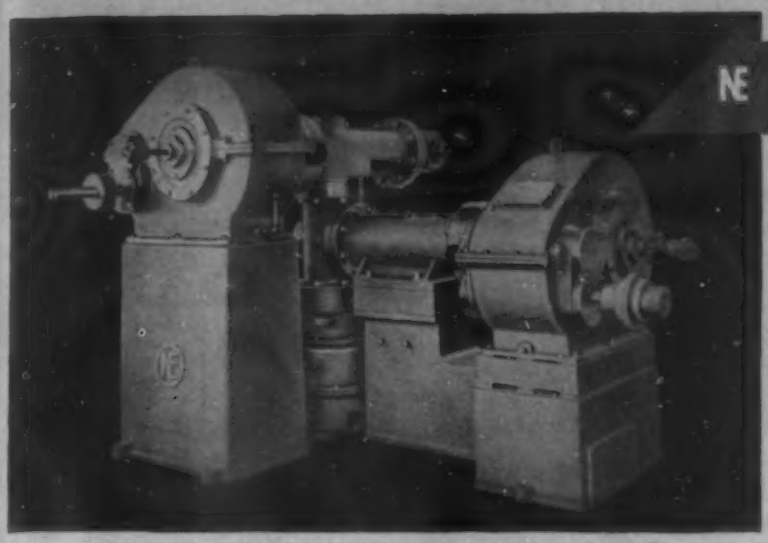
# PLASTICS SCRAP

# MEYER & BROWN CORP.

Founded 1894

347 Madison Ave., New York 17, N. Y.

• ACRYLICS • CELLULOSE ACETATE • POLYSTYRENE • ETHYL CELLULOSE • VINYL RESINS •



4½" NE Triple Stage Extruder with five heat control zones

## NE *Triple* STAGE EXTRUDERS

National Erie engineers have recently developed a compact 3 stage extruder that offers thorough plasticizing of difficult plastics.

An independent drive is provided in each stage with progressive controlled heating.

NE Single, double and triple stage extruders permit us to offer the right extruder for the job. Consult with NE engineers.

*Write for Booklet*

**NATIONAL ERIE CORPORATION**
*Erie, Pa. U. S. A.*

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thermoplastics scrap BOUGHT

reconditioned molding powder SOLD

***SELL US YOUR THERMOPLASTIC WASTE.*** *Sell us rejected molded pieces or obsolete molding powders—cellulose acetate, cellulose aceto-butyrate, polystyrene, methyl methacrylate, or polyvinyl resin.*

***WE SEPARATE ALL CONTAMINATIONS,*** *removing steel or other mixtures—metal or anything else—and rework and plasticize the material into first class, ready-to-use reprocessed molding powder.*

***BUY FROM US*** *when reconditioned molding powder is needed for your process. You'll find our product a trustworthy and reliable element. Contact us at our modern plant. Inquiries will receive prompt attention.*

**A. BAMBERGER**
*plastic materials*

**Call or Write**

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Evergreen 7-3887
Cable: Chemprod

THERMOPLASTIC Scrap

# BOUGHT — SOLD or RECLAIMED for You!

ACTIVE IN THE PLASTIC FIELD for 22 YEARS

A complete converting service! It will pay you to investigate our facilities for reworking your scrap.

CELLULOSE ACETATE — CELLULOSE BUTYRATE
STYRENE VINYL AND ACRYLIC RESINS

GP PLASTIC MATERIALS

*A Dependable Source of Supply for re-worked Cellulose Acetate and Cellulose Butyrate molding powders*

## GERING PRODUCTS INC.

North Seventh St. & Monroe Ave., KENILWORTH, N. J. Chicago Office: 622 W. Monroe St.

## An ARM CAN DELIVER UP TO 15 TONS PRESSURE

Exclusive Famco gib adjustment keeps ram aligned, compensates for wear, eliminates "shimmy."

Famco Arbor Presses are the low cost solution for thousands of assembly and dismantling jobs. They require no electric power, yet are easily operated by women. They're available in 32 ruggedly constructed models, (for bench or floor mounting), in plain lever, simple ratchet or combination compound and simple ratchet types. See your Famco dealer or write today for catalog.

**FOOT-POWERED MACHINES THAT USE NO POWER**

Famco Foot Presses for light forming and stamping are available in 10 models (for bench or floor mounting.) Low cost, low upkeep.

Famco Foot Powered Squaring Shears will cut up to 18 gauge mild steel with ease. Available in five ruggedly constructed sizes.

FAMCO MACHINE CO., 1385 18th Street, RACINE, WISCONSIN

famco ARBOR PRESSES FOOT PRESSES SQUARING SHEARS

## THE RACE IS TO THE EFFICIENT!

*for Speed and Economy*

We're entering an era of severe competition. The race will be to the most efficient. That's why we urge you to investigate the speed and economy of Hobbed Cavity Molding. Hundreds of our clients report amazing economies without the slightest sacrifice of molding accuracy.

## HOBBED CAVITY MOLDING

NEWARK DIE COMPANY
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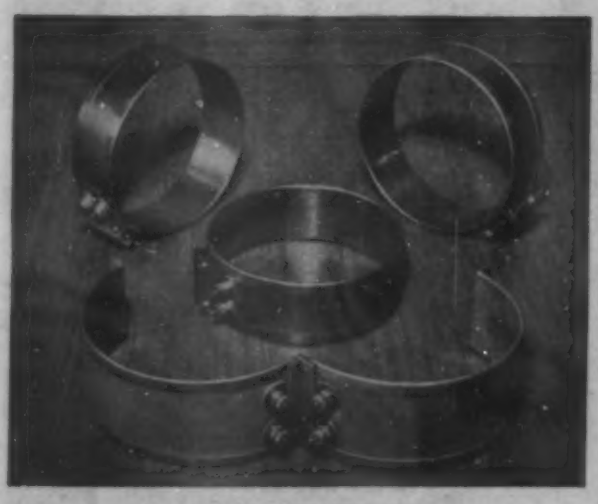
# Plastic Marking

## IN GOLD, SILVER OR COLORS

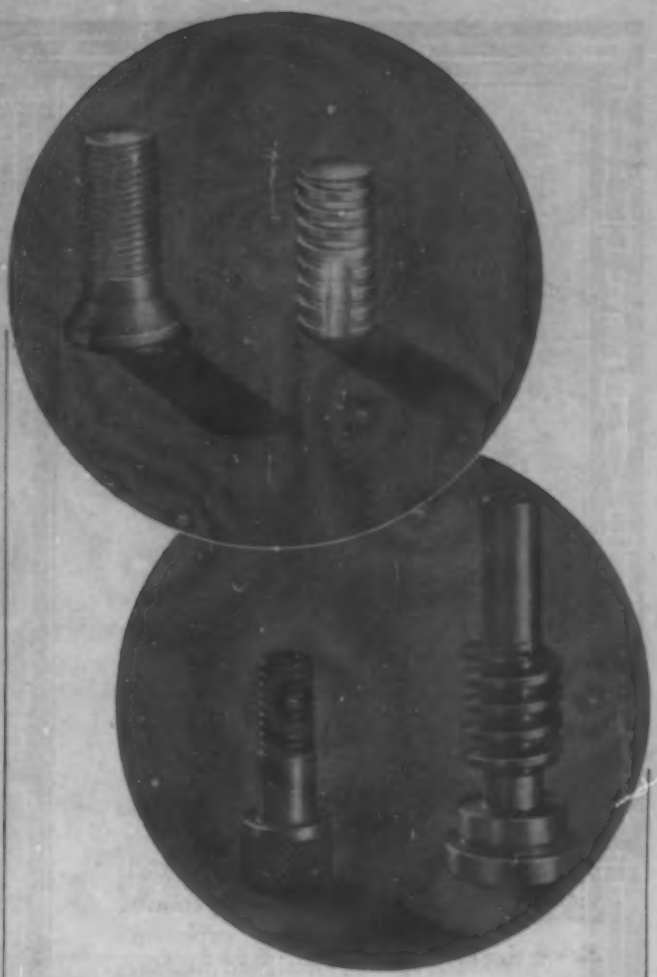
Small Designs, Trade Marks, Names, etc.
Clean-cut precision markings on plastic parts at production speeds up to 1,000 per hour, using unskilled operators. Send samples and details of your stamping problems.
Kingsley GOLD STAMPING MACHINE CO.
★ HOLLYWOOD, CALIFORNIA ★

## ELECTRIC HEATING EQUIPMENT FOR THE PLASTICS INDUSTRY



HINGED TYPE BAND UNITS (illustrated) for all injection moulding machines; Size and Wattage to your specifications. Also space, strip, cartridge and immersion heaters—for the industry. We manufacture hot plates and ovens as well. Send us your heating problems.

**GLENN ELECTRIC HEATER CO.**
239-241 Canal Street New York 13, N. Y.



## SIMILAR DESIGN...

### ... DIFFERENT MATERIALS

HARTFORD offers you a proficiency you can use profitably in the competitive years ahead . . . metal or plastic component parts from Rod or Tubing . . . screw machine products by design of methods based on expert engineering knowledge . . . secondary equipment unusually diversified for precision production of complete mechanical assemblies.

**PLASTICS**
From Rod & Tubing

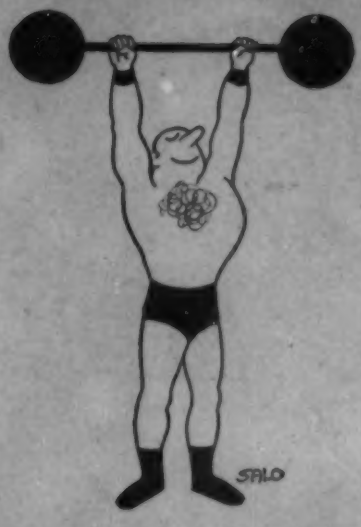
*Centerless Ground • Machined • Borizing • Slotted Milled • Knurled • Drilled • Threaded • Tapped*

*Metal Inserts*

**SCREW MACHINE PRODUCTS**
1/64" to 5" Dia. All Metals

★

**THE HARTFORD MACHINE SCREW COMPANY**
HARTFORD, CONNECTICUT
Since 1876




# CAPABILITY...
## in the hard-to-do

When you are up against a problem on a special part for your product, call on our consultant service. We'll be glad to help at no obligation to you. Our engineering experience and our specially designed machines are both geared to making the hard-to-make special parts. And usually our cold-forged specialties will save you money, too.

*This Decimal Equivalents wall chart is accurate to four places and signalled in three colors. Yours at no cost or obligation. Just send us your name, title and address.*

*See our Catalog in Sweet's File for Product Designers*

**JOHN HASSALL, INC.**

*Specialists in Cold-Forging Since 1850*

**396 Oakland St., Brooklyn 22, N. Y.**

SPECIAL NAILS RIVETS SCREWS

Hassall

# The KANE BOILER
## . . . for New Products

Now that materials have been released for general use, much equipment still in the design stage will soon be placed in production. When writing specifications, engineers will include the scientifically designed KANE, where service indicates an automatic, gas-fired steam boiler, in sizes up to 30 H. P.

If you will get in touch with us, our engineering department will recommend the type, size and pressure of boiler best suited to your needs.

Give us this information—make a list of your presses, indicate the size and number of platens to be heated in each press, specify the molding temperature required, and state whether operation is heat and chill, or straight heat.

Efficient equipment including a KANE boiler will put your plant into shape to turn out its share of the ever-increasing plastic production.

MEAPE KANE OFFICE

Manufacturers of Automatic Steam Boilers for over a third of a century

1903-1915 EAST HAGERT STREET, PHILADELPHIA

# ORGANIC PEROXIDES

CATALYSTS FOR POLYMERIZATIONS
DRYING ACCELERATORS · OXIDATION AGENTS · BLEACHING AGENTS

LUCIDOL*
(BENZOYL PEROXIDE)

LUPERCO*
(PEROXIDE COMPOUNDS)

ALPEROX* C
(TECHNICAL LAUROYL PEROXIDE)

LUPEROX*
(PEROXIDE PASTES)

Special Organic Peroxides

* REGISTERED TRADEMARK

LUCIDOL CORPORATION

BUFFALO (5) N. Y.

# A BATTERY OF BLODGETTS RECOVER PLASTIC SCRAP

Brooklyn Plastics Co., B'klyn, N. Y., uses a battery of Blodgett No. 151 Gas-Fired Ovens, one of them below, to recover the Lucite and Plexiglas scrap, at right. Cut into usable size and softened and flattened in these ovens, this scrap is sold to manufacturers of thousands of plastics products, who, in turn, use Blodgetts.

Scrap recovery is but one of the manifold applications of Blodgett Ovens to the plastics field. For preform heating and for any number of other operations, moulded and fabricated plastics manufacturers prefer the ease and economy of low-cost, controlled heat—as supplied by Blodgett Ovens. Fiberglas insulation, thermostatic control—and the right size to meet *your* problem!

*Write for folder PF-1-45*

**The G. S. BLODGETT CO., Inc.**

**53 Maple Street, Burlington, Vermont**

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## *Experience Is the Answer to Plastic Problems*

**The molded plastic business cannot be learned over night as some people seem to believe.**

**In fact, the knowledge of properly molding each of the many different plastic materials requires years of actual experience. Each characteristic requires special handling learned from scientific research and actual production.**

**Because our organization is built around men of long experience we are able to obtain the finest results from any of the following materials:**

| | | |
|---|---|---|
| Bakelite | Lumarith | Resinox |
| Durez | Lucite | Saran |
| Ethocel | Plaskon | Tenite |

CUSTOM MOLDING

M

EXTRUSION
INJECTION
COMPRESSION

**MICHIGAN MOLDED PLASTICS, Inc.**

*Dexter, Michigan*

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*Service with a punch!*

● Allied's R-B Interchangeable Punch and Die is "standard" in metal working and plastic industries. Standard shapes and sizes carried in stock. Illustrated are four of the thousands of specially-designed punches we have made. Special R-B punches and dies made in any material, shape or size desired. Send for large, illustrated R-B catalog, now.

**ALLIED PRODUCTS CORPORATION**

**Department 28-E • 4622 Lawton Ave. • Detroit 8, Michigan**

All type H blocks are 2" wide

All type S blocks are 2½" wide

# STOCK MOLD TERMINAL BLOCKS

Standardized, stock-mold terminal blocks to serve all war industries quickly and efficiently are in steady production at Insulation Manufacturing Company's plant.

Type H (Bakelite) comes in four sizes: 4, 6, 8, and 12 terminals. The 6 terminal block is illustrated. It is available with copper grounding strip, plastic covers and white marking strip.

Type S (Shellac) comes in three sizes: 4, 8, 12 terminals only.

These blocks are standard circuit connectors in many industries. The molds are ready-made and can be put on presses to deliver any quantity.

We have been molding plastics for more than 50 years to specifications for all industries. This custom molding service is available to all essential industries to produce any number of plastic parts in all shapes and sizes. We design and construct all our own tools and molds to insure quality and to save our customers' time.

## Insulation Manufacturing Co.

CUSTOM MOLDERS OF PLASTICS FOR INDUSTRY

11 NEW YORK AVENUE • BROOKLYN, N. Y.

# PLASTIC MOLDS

25 years experience in designing and building molds for leading molders.

Our plant is modern in equipment for producing the best in molds. Compression, Injection, Transfer.

SOCIETY OF THE PLASTICS INDUSTRY · SPI

## FORTNEY MFG. CO.

247 N.J. R.R. Ave.

NEWARK 5, N. J.

## ...at a saving!

• Metasap Stearates help meet the demand for better lubrication needed by today's plastics industry with its intricate mold design and greater precision in the manufacture of molded articles. Metasap products permit operations at lower pressures —they penetrate to the surface of the compound to give a clean-cut finish—they eliminate the need of after-treatments involving buffing operations. Result—improved internal lubrication and a clearer molding job at worth-while savings. For complete information write,

METASAP CHEMICAL COMPANY, HARRISON, N. J.

CHICAGO • BOSTON • RICHMOND, CALIF • CEDARTOWN, GA.

A Division of National Oil Products Company

METASAP CHEMICAL COMPANY

Stearates

of Aluminum · Calcium · Lead · Zinc

COLORFUL DURABLE DEPENDABLE SALEABLE

Fabricated PLASTIC FILMS
VINYL • BUTYRAL
CELLULOSE ACETATE
for
Wearing Apparel, Sporting Goods and Household Items

Laminated PLASTICS
OF ALL TYPES
VINYL
BUTYRAL
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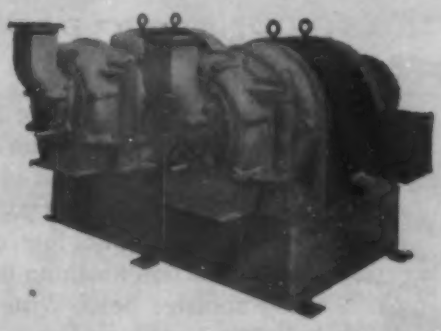

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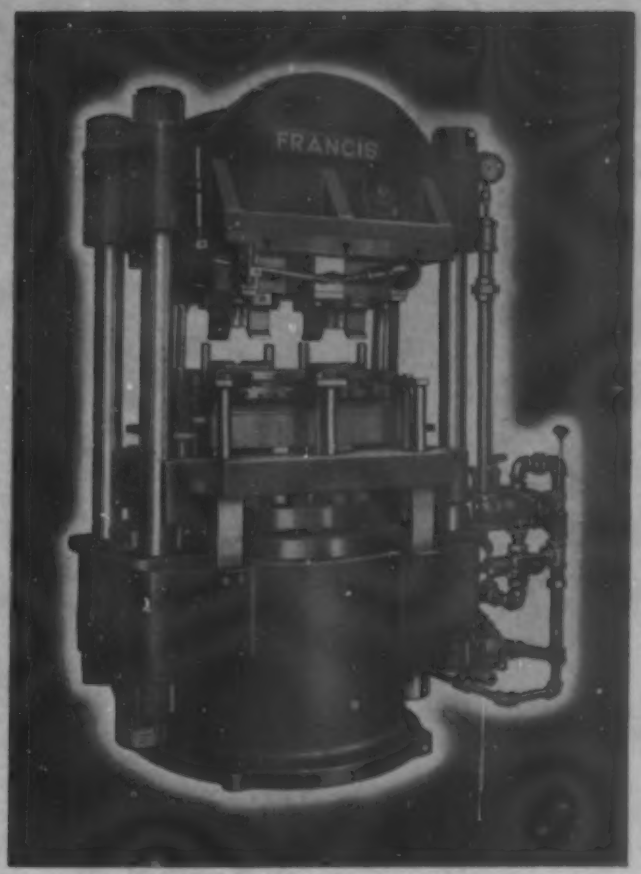


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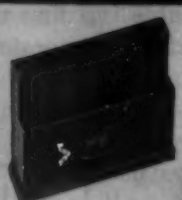

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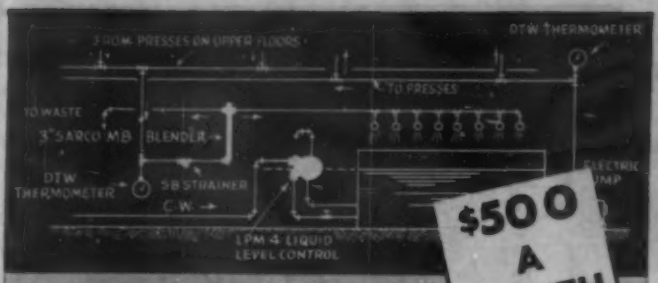


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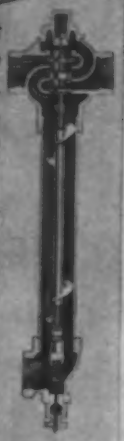

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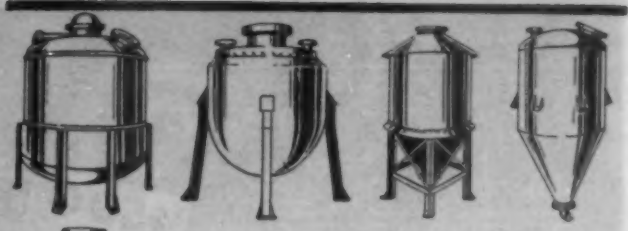

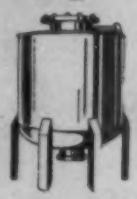

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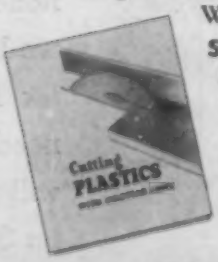


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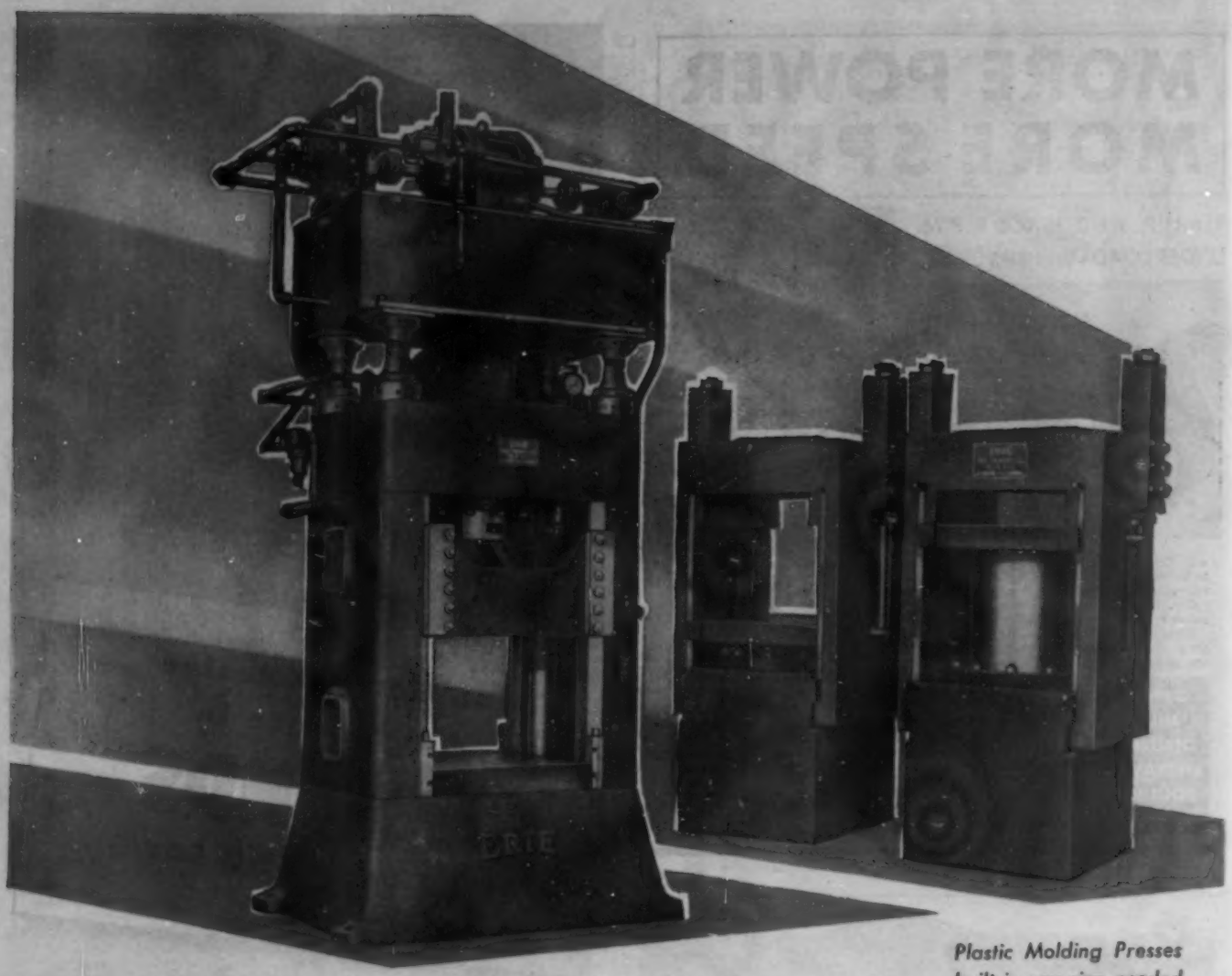

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WANTED: Small or medium sized plastic molding plant with either hydraulic extrusion or injection equipment with or without tool shop. Advise full details. Reply Box 788, Modern Plastics.

FOR SALE—1—French Oil Hydropneumatic Accumulator; 1 Worthington Hyd. Pump 1 x 6, 5 GPM 6000 pressure M.D. 1—14" x 24" Press, 9" ram; 4—24" x 55" steel cord Heating Platens; 4—W. & P. Mixers; 1—Thropp 10 x 24" Rubber Mill, 1—8 x 13" Rubber Mill; 1—set of 18 x 50" Compounding rolls, reduction gear and motor; 1—Stokes Rotary 32 punch Preform Press; 6—Hydraulic Presses, 20 x 20", 12 x 14"; Allen 6" Tuber; Dry Powder Mixers; Pulverizers, Grinders, etc. Send for complete list. Reply Box 1310, Modern Plastics.

Long established reputable concern with substantial capital will buy for cash, Assets, Capital Stock, Family Holdings of industrial plants, mfg. divisions, units. Among other considerations, you may realize certain desirable tax advantages. We are principals and act only in strictest confidence, retaining personnel wherever possible. Address Box 1230, 1474 Broadway, New York 18, N. Y.

DRAFTSMAN-ENGINEER—Duties to include designing of die casting dies and fixtures for progressive manufacturing plant located in New York City, established over 25 years. Permanent post-war position. Excellent future. Give full details of experience and salary desired. Reply Box 1296, Modern Plastics.

IN THE MARKET FOR: Stainless Steel or Nickel Kettles, Vacuum Pan, Preform Machine and Mixer, Hydraulic Presses. Reply Box 825, Modern Plastics.

WANTED: THERMOPLASTIC SCRAP or rejects in any form, including Acetate, Butyrate, Styrene, Acrylic and Vinyl Resin material. Submit samples and details of quantities, grades and color for our quotations. Reply Box 508, Modern Plastics.

Do you need a Hydraulic Press for Compression Molding, Transfer Molding, Laminating, Forming, Bending and Hobbing? Whatever it may be, if it is hydraulic, see Sal-Press Company, 388 Warren Street, Brooklyn, N. Y. Specializing in rebuilding of new, and used hydraulic equipment.

Top flight engineer, Excellent record on highest precision extruded sections. Interested in organizing proprietary extrusion for East Coast firm. Box—#1347, Modern Plastics.

FOR SALE: 1—500 ton Hydraulic Press with downward moving ram and pushbacks. Box 512, Modern Plastics.

FOR SALE: Hydraulic Presses, 600 ton Watson Stillman double acting downward ram platen 24" x 24", 1-36" x 36" 12" ram, 200 ton all steel construction 3-20" x 20" 10" rams, 1-24" x 24" 6" ram, 75 ton capacity, 1-52" x 26" x 14" ram, 400 ton capacity, 4-15" x 15" 8½" rams, 2-12" x 12" 7½" rams, 1-12" x 12" 8" ram, 1-26" x45" 10" ram, 100 tons capacity, 1-18"x18" ram, 200 ton capacity, 1-20" x 24", 12" ram, 200 ton capacity with hydraulic pushbacks, 1 Hanna Hydraulic Cylinder double acting 7" ram, 12' stroke; Pumps: Robertson Triplex 5 GPM 5000 lbs., HPM Triplex 1½ GPM 2500 lbs., 4 plunger vertical 4 GPM 2250 lbs., National Triplex 3 GPM 4000 lbs., Hele Shaw JLP 12, 44 GPM 1200 lbs., HPM 1½ GPM 2000 lbs. on high, 16 GPM 400 lbs. on low, V Belt Drive; Accumulators: Hydro-Pneumatic 4½" dia. plunger, 27" stroke, 18" dia. cylinder with By-Pass Valve; Extruder: Adamson 8" Strainer head, Mills, Calenders, Mixers, etc. Advise your requirements. HIGHEST PRICES PAID FOR YOUR USED EQUIPMENT. Universal Hydraulic Machinery Company, 285 Hudson Street, New York City 13.

Mexican firm with sound financial backing interested in representing American manufacturing of Plastic items on exclusive basis. Cordoba Gomes y Urra, Amsterdam 250, Mexico, D. F., Mexico.

Production Manager Wanted for injection and compression plastic factory located in Ohio. One experienced in decorative plastic production preferred. State experience and references. Excellent opportunity to right party. Reply Box 1316, Modern Plastics.

*INDUSTRIAL DESIGNER* wanted. Must be topnotch. Rendering, styling, successful product experience important, plus ability to meet clients and handle accounts. Excellent permanent future, high salary. Write or visit our office nearest you.

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230 North Michigan Avenue, Chicago.

ATTENTION PLASTIC MOLDERS

Development and production engineer in plastics and metal, with capital, desires association or partnership with plastic molding plant. Has low cost patented and merchandised plastics and metal utility and novelty items for manufacture on profit sharing basis. Reply Box 1328, Modern Plastics.

FOR SALE

1—Rodgers 2 plunger Oil Pump 2 GPM 3000#; 1—Logan Oil Pump 5 GPM 750#; 3—Vickers Oil Pumps 17 GPM 500 to 1000#; 1—Metalwood Horizontal 4 plunger 1 GPM 3000#; 1—Rumsey Vertical Triplex 300 cubic inches 3000#; 2—Deane Worthington Triplex Pumps 400 cubic inches 4000#; 1—Gould Vertical Triplex 24 GPM 2500#; 1—Robertson Vertical Triplex Pump 7 GPM 5000#; 1—Robertson Vertical Triplex Pump 4 GPM 6500#; 2—Gould Vertical Triplex Pumps 200 GPM 500#; 1—Elmes Horizontal 4 plunger 6½ gallons 5000#; 1—Watson Stillman Horizontal 4 plunger 11 GPM 5000#; 2—Galland Henning Horizontal 4 plunger Pumps 50 GPM 2000#; 2—42 x 42" 14" ram presses; 2—80 ton Elmes 17 x 17" downward-moving ram presses; 1—Elmes 50 ton 18 x 18" downward-moving ram press; 2—30 ton Watson Stillman 12 x 12" Laboratory Presses. Reply Box 1225, Modern Plastics.

WANTED: Man with background of thermo-plastics and plastics fabrication to take charge of new plastics container department of long established paperboard container company located in Brooklyn, N. Y. Knowledge of machinery and methods essential. Excellent opportunity to advance with the department. Write your qualifications fully together with age and salary requirements. Reply Box 1329, Modern Plastics.

EXPERIENCED MOLD MAKER

Wanted by an old substantial Southern New England Company having a very modern toolroom. Write for interview, giving details as to experience. Replies will be confidential. Box 1330, Modern Plastics.

WANTED: PLASTICS ENGINEER—experienced with ability to develop new methods for fabricating plastics. Must be able to manage and supervise plant which at present fabricates lucite buttons, handbag accessories and compacts. All replies held in strict confidence. Write fully stating age, experience and salary expected. Reply Box 1332, Modern Plastics.

Fabricator of plastics successfully operating continuously ten years is seeking an experienced molder on injection machines to open own molding plant under a partnership. Or, will consider consolidating with small plant where expansion and increased business volume is desirable. Reply Box 1331, Modern Plastics.

"Industrial designer is interested in making new contacts. Have several designs for post-war plastic articles. Will design or re-style your post-war products.
Mailing address: 312 No. Spaulding Avenue. L. A. 36, Cal."

"Packaging Sales Organization interested in representing manufacturers of packaging lines in the Chicago Market. G. R. Bent & Company, 444 West Grand Avenue, Chicago."

Royalty or patent rights for sale to self-anchoring nut usable in plastics, plywood, metals, and other soft materials. Economical to manufacture; plenty of sales appeal; unlimited applications. C. E. Jump, Newton, N. J."

Manufacturers, please notice. Large handicraft concern with nation-wide distribution looking for the following supplies. Plastic Scraps, Jewelry Findings, Beads and various Dangles for necklaces. Also Plastic Lacings in large quantities. Write Box 1333, Modern Plastics.

WANTED: PLASTICS ENGINEER
To head plastics production of established smaller company. Trained staff, all types of molding presses and tool room facilities. Excellent post-war prospects. Liberal salary and opportunity for advancement to executive rating. Qualifications: Practical experience and training in: design and production of molds, dies, supervision of tool room activity; drafting knowledge; knowledge and experience with injection and compression presses and production. Engineering degree preferred but not essential if applicant has had practical experience and supervision in field. Address Modern Plastics, Box No. 1242, for interview. State qualifications, training, background, and experience.

LARGE FIRM, Sales running into millions, interested in all kinds of novelties and jewelry items, would like to contact manufacturers in metals or plastics. Can finance or purchase raw materials and machinery or factor if necessary. Reply Box 1334, Modern Plastics.

Ass't. Sales Mgr. 29; Now employed in nation-wide sales, promotion and merchandising with multi-million dollar Textile firm, seeks position with progressive plastics firm for post-war development and expansion. Experienced in developing and working with sales staff for retail, wholesale, jobbing and chain store trade. Honorably discharged veteran, college graduate, graduate Plastics Institute. Reply Box 1335, Modern Plastics.

A graduate chemist with ten years' experience in all phases of thermoplastic production and fabrication would like opportunity to set up and manage new plastic division. Would like salary and profit share." Reply Box 1336, Modern Plastics.

WANTED: HEAD MAN FOR INJECTION MOLDING DEPT. Confidential correspondence invited from qualified injection molding superintendent or foreman who would like to take charge of Injection Molding Department of leading established plastics molding company in New York City area. Reply Box 1337, Modern Plastics.

Available for immediate delivery. A limited number of 12-ton Hydraulic Laboratory Presses, 8 x 8 mold capacity, 6-inch stroke. Suitable for compression molding, testing, laminating, preforming, and general plastic applications. Price including heating plates and thermostatic control $210.00 F. O. B. Cleveland, Ohio. Plastic Laboratories, Inc. Box 115, Cleveland 21, Ohio.

TOOLMAKERS DIEMAKERS
ENGRAVERS

Wanted immediately diemakers experienced on plastic molds by plant in Chicago which is a class one labor area. Now heavily engaged in war contracts and with large volume of postwar work assured. These jobs are permanent for men of high skill.

This plant is modern and fully equipped with machines and tools of latest designs. Liberal management policy—vacation with pay, free hospitalization and insurance, plenty of overtime if desired, and many other advantages. Plant located 25 minutes from the center of Chicago . . . fast, frequent transportation in all directions.

Call Graceland 1131 or Pensacola 6622, Chicago exchanges. We will pay telephone charges. Or reply to Box 1338, Modern Plastics.

ADHESIVE CHEMIST—Research and development. Experience in the use and preparation of adhesives of the water dispersion type and cut-back type. Wonderful opportunities for right man. Location—Metropolitan New York Area. Send complete resumes to Box No. 1339, Modern Plastics.

"We invite the representation of well established firms of U.S.A. in every kind of Plastics under Post war planning. Write with full details to H. R. BRIJLAL & CO., Beaumon Chambers, Medows Street, Fort. Bombay."

WANTED

SELL, RENT or LEASE stock dies for injection moulding machines to large Canadian Company. 15 salesmen calling on drug stores, chain, variety, and department stores, also jobbers. Warehouses and sample rooms in Toronto, Montreal, Saint John, N.B., Winnipeg and Vancouver.

SALESMAN Discharged Veteran, Age 34, desires to represent manufacturers of Plastic Consumer Items Greater New York. Jewelry, Department store contacts. College Graduate. Reply Box 1340, Modern Plastics.

We are interested in placing substantial orders for sun glasses of modern design, and also with protective side shoulders. Will firms interested please send samples, or illustrations to Neuburger Products Ltd., 21A Alymer Parade, Alymer Road, London, N.2., England.

Manufacturer and distributor wanted for unique plastic educational toy. Requires stamping, printing and assembling of 4" x ⅜" colored strips.

Patent applied for on this item. Appeals to age group infants to first grade.

Address R. L. Batchelor, 152 West 42nd Street, New York 18, N. Y.

WANTED: Assistant in Plastics Research Lab in Paper Mill. Should also have experience in Latex saturation. Give age, references, experience and salary expected in first letter. Our plastic staff has been notified of this advertisement. Reply Box 1342, Modern Plastics.

Large Eastern chemical manufacturing organization desires to increase its staff and expand resin research, development and production. Men with prior experience are essential. In first letter state your qualifications and the type of polymerization with which you are experienced. There are excellent opportunities for men with proper qualifications for immediate, as well as post-war advancement. Reply Box 1341, Modern Plastics.

"WANTED back numbers of Modern Plastics dated January to July, 1944. Indian Jute Mills Association, Imperial Institute, London, S.W.7."

Well established concern wants man thoroughly experienced injection molding, capable handling department, know mold making, familiar all phases plastic manufacturing. Give full details, salary desired. Address Box 1343, Modern Plastics.

"Plastic & Adhesives engineer available; 4 years experience in fabrication, production, development, and testing of resinous products. Wide knowledge of glues and adhesives of the resin and synthetic rubber type for use in bonding wood, metal, laminates, and misc. materials. Production, development, and practical-minded. Prefer position in Midwest or West involving development, production, management, or technical service." Reply Box 1344, Modern Plastics.

PLASTICS SALES ENGINEER, to represent leading plastics molder in Ohio territory. Practical knowledge of plastics or engineering education essential Write in full details to Box 1345, Modern Plastics.

Plastic Fabricating Plant available for Contract Work. Situated in Monmouth County, New Jersey. Complete in every detail including molding press. Just released from three years Government operation making electronic precision instruments. Years of prewar experience designing and manufacturing Plastic Furniture, Lamps, Radio Equipment, Gift Items, etc. For further information. Communicate Box 1346, Modern Plastics.

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FOR SALE: Two new 200 ton compression presses, one HPM and one Stokes, both self contained. Sima automatic; three practically new electronic units for compression molding. All items for immediate delivery. Reply to Box 1349, Modern Plastics.

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PRODUCT DESIGN & STYLING

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FOR SALE: Farrel Birm., 150 ton Mold Presses; also 25 to 250 tons: 36" x 36", 30" x 40", 16" x 16", 12" x 12", 30" x 36", 24" x 38", 40 ton Broaching Press; 400 ton Extrus. Pr.; W. S. Hor. 4 plgr., 1" & 2" x 4", H & L pressure pump; W. S. 1—¾" x 12" hr. 4 plgr. 30 GPM, 3500 lbs. H.P.M. 1¾" x 6", vert. Triplex, 10 GPM, 2700 lbs.; 2-Oilgear Pumps, 13 GPM 1250 lbs.; Wat.-Farrel 1¼" x 4", vert. triplex, 6 GPM, 3000 lbs., Goulds 2¾" x 8" vert. triplex 30 GPM, 1600 lbs.; Elmes 1" x 4" & 1¼ x 4" hor. 4 plgr., 5 to 8 GPM, 4500 lbs. & 5500 lbs. Rumsey 4¾" x 8" vert. triplex, 65 GPM, 900 lbs.; Elmes 2¾ x 4" hor. 2 plgr., 17 GPM, 850 lbs.; 10 HP horiz. 1¾" x 4" triplex 6 GPM, 3000 lbs.; New Vickers Oil Pumps, 28 GPM, 1000 lbs.; New Vickers 1¼" Oil Relief Valves; New Vickers ¾" Flow Control Valves; No. 2 Extruder; Hy. Steam Pumps; Hand Pumps; Low Pressure Pumps 150 to 600 lbs.; Hydr. Accum., ¾", ⅝" and ¾" Preform Tablet Mach.; Heavy Duty Mixers; Roller Conveyor, Grinders, Pulverizers, Gas Boilers, etc. . . PARTIAL LISTING. We BUY YOUR USED MACHINERY. STEIN EQUIPMENT CO., 426 BROOME ST., NEW YORK 13, N. Y. CANAL 6-8147.

Hydraulic Press, New—never used—with 60" x 110" Steam Platen. Operating pressure up to 500 lbs. P.S.I. Will sell complete with pumps and auxiliaries or separately. Will also sell extra Hydraulic Cylinder—12" diameter 36" stroke operating pressure maximum 3000 lbs. P.S.I. For sale by owner. Reply Box 1348, Modern Plastics.

WANTED: Foreman-Compression molding department of New York manufacturer of electrical products wants foreman having practical experience with molding and preforms. Must know how to set molds in press. Steady work. Advancement. Give experience and salary requirement. Reply Box No. 1323 Modern Plastics.

WANTED: Moldmaker and repairman. New York manufacturer requires man thoroughly experienced with making new compression molds and must be able to repair molds now in use. Excellent opportunity for right man, steady work, advancement. Give experience and salary required. Reply Box No. 1324, Modern Plastics.

FOR SALE: No. 3 Royle Tuber; 6" x 13" Two Roll Mixing Mill; Hydraulic Presses, 12" x 12" to 24" x 24"; 100 gal. W. & P. Jacketed Mixer, sigma blades. BRILL EQUIPMENT COMPANY, 225 W. 34th Street, New York 1, N. Y.

"We are interested in buying for British Commonwealth Country new or used molds for 3 pieces Dresser Set (comb, brush and mirror) suitable for 6 or 8 oz. Reed Prentice." Reply Box 1325 Modern Plastics.

PLASTICS ENGINEER wanted to head a Plastics Laboratory for the investigation and application of plastics to precision mechanical and electrical devices. Man should be a graduate engineer thoroughly familiar with the physical characteristic of molding compounds and the proper design practice for their use. Reply Box 1326, Modern Plastics.

We call on all classes of jobbers covering Minnesota, Wisconsin, Iowa, and the Dakotas and can handle one more line. Jones Brokerage Co. PO Box 763 Minneapolis Minn.

FOR SALE: 2—42" Mills, Spreading Machines, Churns, 1—12" Erie Strainer with Motor, 1-6" Strainer, 1—4" Strainer. Reply Box 1327, Modern Plastics.

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Back of the familiar Universal trade mark are a well-rounded organization and a plant equipped to handle a plastic molding job complete from designing to finishing. The Universal trade mark on a molded plastic product is your assurance of careful workmanship and satisfactory service.

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SOMEWHERE in the South Pacific, American boys are getting a laugh. A much-needed laugh that helps their morale. A laugh your money helps to buy—when you give to your Community War Fund.

For part of every dollar you give goes to the U.S.O. and helps send the U.S.O. camp shows overseas. And, with the millions of men now idle in occupied territories, the need to keep up their morale is greater than ever. That's why the army has asked the U.S.O. to quadruple its activities. And why your money is needed to help bring to some lonely G.I. a touch of home—the familiar face of Joe E. Brown—the friendly voice of Frances Langford—the dancing feet of Fred Astaire.

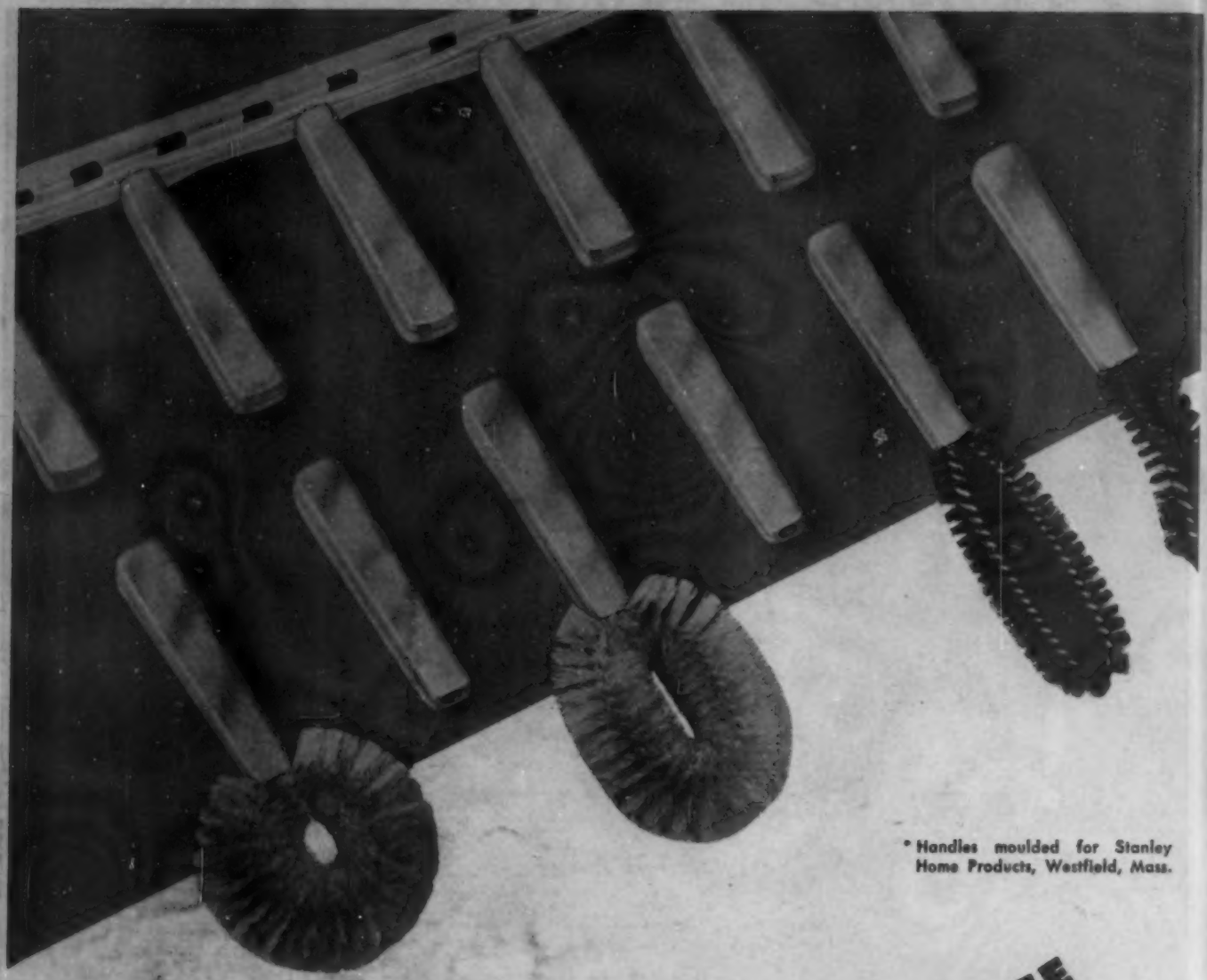
Another part of your money is spent right here at home, to help servicemen's families keep living decently, united in happiness and health. Still another part helps cheer our merchant seamen in distant ports of the world. And it helps relieve hunger and sickness and suffering among our fighting allies.

This is a great united cause. And because the needs are so many and so great, give generously—give more than you gave last year. Make your gift as big as your heart.

Give generously to

## Your Community War Fund

Representing the National War Fund



* Handles moulded for Stanley Home Products, Westfield, Mass.

# A FIRM HOLD ON THE HOUSEWIFE

These Stanley Home Products brushes for complexion, manicure, massage and dental plate get a full share of their appeal to housewives and their usefulness, from the handles — one of our oldest custom injection moulded jobs.

They are an example of our 100% return to peace time manufacture. Through the close of business August 14, war items absorbed 95% of our production. The plant reopened Friday August 16, following the two holidays with every moulding facility devoted to civilian orders, with every employee thus engaged and with a number of additional ones hired. This fact alone has already drawn the attention of, and inquiries from many plastics minded industries. Perhaps it will make you feel the same way about a company whose careful planning and moulding capabilities for **peace** work entirely eliminated any period of reconversion.

*Custom Injection Moulding*

**WORCESTER MOULDED PLASTICS CO.**

14 HYGEIA STREET, WORCESTER 8, MASS.

17 East 42nd St., New York 17, N. Y.
Export Office: 90 Broad St., New York 4, N. Y.

# WHAT TO LOOK FOR IN YOUR NEW WASHING MACHINE....

First thing to look for, *and at*, is the agitator! If it's molded from BAKELITE phenolic plastic BM-13080, developed especially for this use, it's going to assure lasting satisfaction on several major counts. The molded plastic agitator, as proved in more than 6 years prewar service, is far easier on clothes and linen—picks up only one-tenth as much lint as its old style counterpart. Its remarkably light weight puts minimum strain on the drive shaft. This means longer life for the moving parts. Its resistance to shock gives it the stamina to meet the use and abuse of everyday service. Long life is assured by the exceptional resistance of this BAKELITE phenolic plastic to hot water and soap solutions. And to the manufacturer, this material brings the economy of a part that is molded complete in one operation, and requires no finishing.

The savings and improvements that BAKELITE molding plastics offer the washing machine field is only one example of the almost countless problems solved by the use of the *right* BAKELITE plastic for specific applications. Write Department 24 for Booklet G-8, "A Simplified Guide to BAKELITE and VINYLITE Plastics." It may well indicate how you, too, can improve a product while effecting new economies in production.

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# BAKELITE MOLDING PLASTICS

TRADE-MARK

# THE VOICE OF BATTLE—IN PLASTICS

● Here's something new in telephones. It looks much like an ordinary phone—*but this phone needs no batteries or other outside power.* And that meant a lot wherever battles were fought.

Just connect two phones together with a pair of wires—and talk. No power failures to worry about. The trouble, though, is that such "sound-powered" phones must be made with great precision. Ordinary molding processes just wouldn't do.

So RCA engineers brought their problem to No. 1 Plastics Avenue. Result: a battle station telephone that can take it and still dish out the orders. The Navy tests it by dropping it down a 6-foot chute at an 80-degree angle.

General Electric's *complete* plastics service—with many new techniques perfected during the war—is ready to serve all industry in the design and production of better peacetime products. Bring your plastics problem to G. E.—the world's largest manufacturer of finished plastics products. Write to Plastics Divisions, General Electric Company, 1 Plastics Ave., Pittsfield, Mass.

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*Backed by 51 years of experience. General Electric has been designing and manufacturing plastic products ever since 1894.*

**G-E Design and Engineering Service.** Our own industrial designers and engineers work together. Result: plastics parts that are both scientifically sound and good-looking.

**G-E Mold Service.** Fully equipped toolrooms are manned by skilled craftsmen whose average precision mold experience is 12 years. G-E molds are chromium-plated for longer life.

**G-E Quality Control.** Our plastic products may pass through as many as 160 inspections and analyses. Army-Navy rejections were so low as to be negligible at General Electric.

**G-E Research** works continually to develop new materials, new processes, new applications for plastics.

**G-E Manufacturing Facilities** are available for all types of plastic parts—for compression molding, injection molding, transfer molding, extrusion molding, cold molding, both high and low pressure laminating, and fabricating.

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